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UROLOGICAL PROBLEMS¹

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New York

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The span of twenty years covered by the life of the American Urological Association is unquestionably the most important and far-reaching that will be known in the history of urology. Born at a time when urology was branching off from the realm of general medicine and surgery—the actual division becoming necessary through the clarification of the field by precise and accurate methods of study, such study opening up problems connected with each organ of the genito-urinary tract which required for their solution the indvided efforts of individuals—the American Urological Association, built on broad, democratic principles, became a vital factor in the advancement of the specialty.

It has been said that the sound practices of today were but visions the day they were born. Many of the urological problems which had arisen previous to the organization of this association have since developed into sound practices. These were the visions of internists, pathologists and surgeons; for few men, at that time, had devoted their efforts solely to the study of urology.

Previous to the organization of the Americal Urological Association but one large society, the French Urological Association, was in existence. A limited society, composed of a number of general surgeons especially interested in genito-urinary surgery, venereologists, and the first few urologists in this country, had been in existence in America for sixteen years, doing pioneer work of a high type. The time was most opportune for the establishment of a large national society, through which the evolution of uro-

¹Presidential address before the American Urological Association, Atlantic City, N. J., April 26, 1922.

logical problems in the male, female and child could each year be placed before all those especially interested in the subject for discussion and acceptance.

Branches of this association, which were established throughout the country, carried out the work during the year, bringing together the various local groups of urologists, in the only urological meetings held in the various large centers. These branches at once exerted a powerful influence, both in arousing interest in urology and in placing urology in its proper position in the profession.

It is my particular desire on this occasion to recall some of the urological problems which existed at the time of the founding of this association, and briefly to review what has been accomplished, especially by members of this organization, toward their solution.

The early pioneer work in urology, as before stated, was carried out largely by individuals of unusual vision and skill, engaged in general medicine and surgery, rather than by an organized development of urology as a specialty. The individual achievements of the first English, French, Teuton and American investigators in this field have been related in a most interesting manner by Bransford Lewis in the first published presidential address before this association.

During this period the name of Nitze stands out preëminently. When the close analysis is made of the real origin of urology as a special field of study and accomplishment, it is realized that the detailed study of the urinary tract, made possible by the modern cystoscope, led to accuracy which entitled it to be considered a specialty. The use of this instrument, perfected by various modifications, opened up all the problems of modern urology that presented twenty years ago. Previous studies in bacteriology, pathology, physiology and surgery had been of great value, but now urological study could become specific. This study, involving the expenditure of time and skill, developed real specialists.

The next step was a division of work, not only to the extent of the urologist's ability to make an accurate diagnosis, but, with the first-hand knowledge obtained by careful observation

and painstaking manipulation, to carry through; to treat the patient, to operate were surgery necessary. Here strong opposition was encountered. While it was generally acknowledged that special skill was necessary for diagnosis, the treatment or operative genito-urinary work was thought by internists and surgeons to be their part. The early years of the American Urological Association, therefore, were marked by strife on the part of its members for the reception of urology as a specialty.

In 1911 our then president, Hugh Cabot, presented a convincing address, "Is urology entitled to be regarded as a specialty?" His arguments were logical and clear-cut. He pointed out the fact that urological cases were not as well handled by the general surgeon as were the average surgical cases. In reviewing the chief urological problems, *i.e.*, disease of the prostate, stone in the bladder, ureter and kidney, and diseases of the kidney, he showed what had been accomplished at that time through accurate diagnosis and skilful manipulation, in lowered mortality and better functional results; the urologist's figures showing the balance on the side of the specialist. Cabot drew attention to the fact that important discoveries in the field of urology during the previous ten years (1902 to 1912) had come from those who devoted the chief portion of their time to special work.

The following year Louis G. Schmidt followed up Cabot's address with a similar one, "Why urology should be considered a specialty," basing his arguments, as Cabot had done, upon work accomplished. Schmidt called attention to the fact that with the rapid development along diagnostic lines surgery in urology had become prominent and dominated some individuals to the extent of overshadowing all other phases of urology. His entreaty to devote ones energy to the field of urology in its entirety was timely. The importance of borderline cases in urology, the relationship of the urologist to other specialists, and the necessity of team work, were emphasized.

These addresses came ten years after the foundation of the American Urological Association, after an active growth in urology, at the period when urology was being recognized but was

not yet given its full value. The formation of the Section of Urology of the American Medical Association at this time caused further recognition of the specialty, thus strengthening the American Urological Association.

Some of the most important advances toward the solution of the many problems facing the new era in urology during the first ten years of the life of this association were brought about by its members. Lewis, Young, Buerger and others, perfected the cystoscope for diagnostic purposes, adding the operative accessories for treating and operating upon various bladder and urethral lesions. The combined application of X-rays and cystoscopic methods of diagnosis by the use of the opaque ureteral catheter was developed by Schmidt and Kolischer and amplified by many others. The outlining of the kidney pelvis and ureter by the injection of solutions opaque to the X-rays, while suggested abroad, was developed largely by members of this association. One of the first presentations on this subject was by Keyes.

With the vast amount of clinical material for study, and with his ability to analyze it, how much we owe to Braasch for his observations and presentations on vital urological subjects during this period! His development of pyelography, exposition of diagnostic data, classification of cases in numbers so convincing, went far toward the establishment of standards of diagnosis, prognosis and surgical procedure, and the applicability of treatment of urological lesions.

It was during this period that functional kidney tests became practical and accurate, culminating in the phenolsulphonphthalein test presented by Geraghty and Rowntree in 1910. The importance of functional tests in urological diagnosis and surgery was then realized and amplified by extensive reports by Schmidt and Kretschmer, Keyes and Braasch. Second to the perfection of cystoscopic investigation, the placing of kidney function upon a sound basis added more to the advancement of urological surgery than any other one step. The studies in blood chemistry in relation to urology the first presentation before this Association by Gradwohl and Scherck was another step forward.

At this same time another member of our association Edwin Beer, gave great impetus to the study of bladder tumors by his discovery that certain vesical growths could be destroyed by the high frequency spark applied through the cystoscope. Immediately a differentiation of bladder tumors was made which was the beginning of the extensive study which has continued to this time.

By his perfection of technique in perineal prostatectomy, with the corresponding lowered mortality, Hugh Young did more toward bringing urological surgery, as a specialty, before the profession in this country than has been accomplished by any other one man. He proved, at a critical time and in a convincing manner, what could be accomplished by proper methods of diagnosis, preparation and operative technique. One of the most common, as well as most vital, pathological conditions in the urinary tract was placed on a sound surgical basis and we owe him a debt of gratitude for his epoch-making advances in urological surgery at this time. His results spurred on surgeons employing other methods of technique, to better deeds and started a general advancement in prostatic surgery, accompanied by a later more minute and extensive study of the anatomy and pathology of the prostatic by Chute, Tenny, Fowler, Lewis and latterly Lowsley and Randall with a presentation of less radical measures of relief in certain types of obstruction, developed by Chetwood, Young, and others.

The more careful investigation of cases gave rise to advances in the surgery of the genital tract. Contributions by Fuller, Belfield, Young, McGowan, Cunningham, and Barney, showed the surgical importance of this tract and gave impetus and accurate methods of coping with the pathology presented in the testes and seminal vesicles.

In ureteral and kidney surgery more accurate diagnosis and the comparative safety of operations as regards mortality, led to extensive surgery—the over-stimulation of a new field—to be modified and stabilized by observations and results later published.

The venereal side of urology, during this period, was relegated to a secondary position. The treatment of venereal diseases and especially of their surgical complications, advanced, as was natural, with the general swing forward but the classification of the urologist as a venereal specialist disappeared at this time.

At the end of the first decade of the life of the American Urological Association, a ten-year period so full of new urological problems and the remarkable work done toward their solution, such work being carried out by those devoting their entire time and best efforts to this field, certainly Cabot's address was most opportune. The question, "Is urology entitled to be regarded as a specialty?" might seem unnecessary in retrospect, yet those who had gone so far toward solving the many problems in urology were still fighting for recognition and a fair opportunity to follow out their work. A certain amount of recognition of the urologist was present among the profession at large; he was regarded by many as an accessory, or possibly a necessity up to a certain point, but the investigations so carefully worked out by him, placing in his mind, step by step, the picture of the pathology presented, was not in many instances to be carried to the end by the urologist personally supplying the relief from a thorough understanding of the case and by the exercise of special skill.

Have the accomplishments of the last ten years (1912 to 1922) justified the stand taken by Cabot and Schmidt, in their presidential addresses and by other urologists? The most convincing argument is results. What are some of the results of the last ten years in urology? There has been a continuation and advancement in the study of all urological problems.

The treatment of venereal disease, aside from its surgical complications, has become a medical problem. It has become a side branch of urology, as evidenced by perusing the programs of urological meetings. I would not minimize the importance of the treatment of venereal diseases, the worst menace to society today. That the treatment has advanced is shown by the ever decreasing number of urethral strictures, while the instances of prostatic abscess, epididymitis, infection of the vesicles and

arthritis, are less common, are diagnosed and cured, often, by surgical procedure.

Tumors of the testicle have been classified and proper surgical procedures outlined. The work of Hinman and of O'Crowley on this subject should be mentioned. Tuberculosis of the genital tract has been carefully studied and the results of its surgical treatment are most encouraging. This work was stimulated by Young, Quinby, Cunningham, and others of our members.

The surgery of the prostate is a monument to modern urology. The possibility of taking a man of advanced years from the realm of invalidism and a life of misery and placing him again on his feet to enjoy his remaining years in comfort; to be able to accomplish this with a mortality risk of well under 5 per cent, although often in the face of serious complications, is a feat that cannot be surpassed in any other field of surgery. This has not been due to operative skill but to the careful study of the patient as regards complications; to the study of kidney function, of bladder lesions, such as stone, diverticulum, or growth, bladder and prostatic cancer. While any surgeon of moderate skill may enucleate a prostate, the general surgeon could never, upon his own resources, have placed prostatic surgery upon its present basis, nor can his records in such cases stand comparison today beside those of the urologist as regards mortality or functional results. Supplementing the pioneer work in this country of Watson, Fuller, Chetwood, and Young, one could mention the names of a great many of our members, each adding his bit to the sum total of our present standards.

Bladder surgery became a highly specialized branch with the advance of diagnosis. Operative cystoscopy, with the further mechanical improvements in cystoscopes, urethroscopes and accessory instruments, has become a broader field of great usefulness. The removal of foreign bodies, calculi and tissue for diagnosis; the destruction of tissue outgrowths about the vesical neck and of benign papillomata by fulguration, as well as local bladder treatments, are some of the achievements. Lower, Pilcher, Gardner, Chute, Young, Squier, Schmidt and the Mayo

Clinic contributed largely to the surgical treatment of diverticulum of the bladder.

With the treatment of benign prostatic obstruction placed upon a sound surgical basis, the problem that has become paramount during the past ten years is that of malignancy in the prostate and bladder. The great success of fulguration in destroying benign papillomata was followed by its failure in malignant growths. Surgery alone in bladder and prostatic cancer had been a disappointment in many cases. Diathermy, X-rays, and radium, with or without surgery, for the relief of cancer of prostate and bladder, have been the subject of many papers and valuable discussions at symposiums held by this association. The reports of scientific work in this field are encouraging. Those of Beer, Barringer, Young, Keyes, Squier, Pilcher, McCarthy, Kolischer, Gardner, the pathological studies of Geraghty, Buerger, at the Mayo Clinic and by many others of our members have been advances in the right direction. Here we have a problem as with cancer in other parts of the body. A careful, unprejudiced study of these bladder and prostatic growths, with reports of cases treated and free discussion at our meetings, will be of great aid in maintaining a mental balance through the various phases which are traversed in taking up newer methods of treatment of this baffling problem. If from each report some slight advancement is noted we are progressing and with all keenly alert in the study of these distressing cases, possibilities of cures will be more commonly attained.

The past decade has been one of steady progress in the study of ureteral and kidney pathology and its proper management, from both the surgical and non-surgical standpoints. The perfection of pyelography, making it a safer procedure, and the publication of Braasch's work on the subject, established this as one of our most valuable means of diagnosis. Errors in diagnosis of ureteral and kidney lesions were minimized and the more careful outlining of surgical procedures was made possible.

Intraureteral manipulation of calculi, ureteral catheter drainage and pelvic lavage have become valuable procedures to which so many of our members especially Kretschmer, Caulk, Hunner,

Koll and Crowell have contributed. The importance of ureteral lesions in their association with renal lesions has been emphasized. The careful study of renal infection and relationship to focal infections and systemic conditions has been placed, during the past ten years, up on a sound basis. The contributions of Cabot and Crabtree, Schmidt, Chute, Braasch, and many others, have been valuable. Urinary tuberculosis has been the subject of much consideration, and our knowledge of this important disease has been advanced by the many papers presented at symposiums held by this association. This advancement has resulted not from the fact that a tuberculous kidney can be removed by a skilful operation, but because early diagnosis of the lesion is possible, a study of the urinary tract is made, and, with a thorough understanding of the disease, the treatment is carried out to a cure.

Renal calculi have been studied and more or less fixed methods of procedure outlined through extensive clinical studies from the Mayo Clinic and by others. Surgical mistakes in lithiasis are now rare, and the percentage of cures is high. The presence of renal anomalies has been ascertained and their importance understood. Here again the vast amount of material for clinical study at the Mayo Clinic has enlightened us. Renal tumors are detected early by pyelogram and a cure is possible in some cases, whereas all were once fatal. Barnett and Braasch have given us important data concerning polycystic kidneys. Valuable experimental work in urology has been carried out by Quinby, Barney, Hinman, and at the Mayo Clinic.

Much has been added to the study of the urinary tract in the female by the members of this association. Once considered a subdivision of gynecology, it has been found that for the solution of the various problems peculiar to the urinary tract in the female, the broad viewpoint of the urologist gives a firmer and more accurate grasp of the pathology presented and treatment necessary for its relief than does that of one who focuses upon the pelvic organs. The work of Hunner has served as a stimulus resulting in a more careful study of the female urinary tract, especially regarding infectious, ureteral and bladder lesions.

Obscure urinary lesions in children are now given over to the urologist for study. The contributions of Chute on this subject were timely.

Have the problems placed before the urologist ten years ago been handled by him in such a manner as to justify the assertion made by our presidents of 1911 and 1912, that urology is entitled to be considered a specialty? Cabot said

A department of medicine becomes a specialty when our knowledge of the diseases of this department becomes so far developed that it requires the whole time of any individual to keep abreast of the accumulating knowledge and *still have time* to devote to study of the problems presented.

Can any one doubt that the past ten years have proved this to be true of urology? A comparatively obscure field has become an exact science through the efforts of those giving their entire time to the special field of endeavor.

The work is but started; one scientific lead points to something further. All of the problems are still with us for perfection, some still for solution, as in cancer of the prostate and bladder. Much is yet to be proved regarding the etiology of various pathological lesions with a view to preventive urology. The value of the work already done is becoming known not only to the profession at large, but to an enlightened public which will demand services of a specialized order even though a tendency to limit the activity of the urologist may still be present to a certain degree in the profession at large.

With such rapid progress, the possibility of over-specializing must come up for consideration. Proper training of the urologist will help to eradicate this. Several years in general medicine and surgery preceding a urological training, which must be thorough in special anatomy and pathology, cystoscopy and urological surgery, will give a broad viewpoint to the urologist and an appreciation of the relation of urology to the various branches of medicine and surgery. He will be able to study and relieve the patient. He will retain his proper standing as an individual and as a member of any group.

The American Urological Association has played an important rôle in this advancement. A survey of the various branch societies through those influential in their organization from the foundation reveals the fact that the branch societies, with their position in the respective districts, have had a decided influence toward the advancement of urology. In only one section is there now a local society, other than the branch of the American Urological Association, holding urological meetings throughout the year. The presentations at the meetings of the branches are very largely by local members. The interest in each branch is increasing, although further subdivision of territory will be necessary to maintain interest in local branches where distances of travel are great.

Two years ago the American Urological Association took over the management of the *Journal of Urology*, making it the official organ of the association. This is a journal of which we may be justly proud. There is no better in existence. The papers read at the national society meetings are here published and it is hoped that the reports of the local branch meetings may be reported, in abstracts at least. The publications to date have been of a high order, demanding recognition throughout the world. Let each member do his utmost to further the success of the *Journal of Urology*, one of the most powerful influences of the association for the advancement of our specialty.

The American Urological Association is unique in its organization. A national society supported throughout the year by local branches, may it exert its utmost influence to place American urology on the plane it deserves! Its members have given largely to the progress that has been made and will continue both individually and collectively to contribute to their fullest in the future.

THE HOMOLOGUE OF THE PROSTATE IN THE FEMALE

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Attempts to homologize certain structures of the female urogenital system with the prostate of the male have been made by a number of investigators and have led to a variety of conclusions. Unfortunately the majority of hypotheses set forth are of a speculative nature and are not based upon sound embryological evidence. Perhaps the greatest sources of error have arisen from a lack of comprehension concerning the homologous divisions of the male and female urogenital organs and to the fact that not enough attention has been paid to the later stages of development. It is the purpose of the present paper to present briefly the results of a comparative study of male and female urethrae based upon serial sections of pelvises at various stages of development. For the description of the developmental stages in the male, the reader is referred to my previous paper on this subject (Johnson, 1920).

As early as 1853, Virchow discussed the possibility of a prostatic homologue in the female. He observed what he considered to be concretions in the urethral glands of old women and noted that in cases of "female hermaphroditism" the concretions were especially numerous. From these observations he concluded that the urethral glands of the female were homologous with the prostatic glands of the male.

It remained, however, for Tourneux in 1889 to show embryologically that Virchow's hypothesis was correct. Tourneux described the glands of the adult female urethra which he found distributed along its whole length but larger and more numer-

ous in its distal portion. He states that these glands have a structure similar to the prostatic glands of a five to six months old male fetus. Tourneux, however, did not observe the prostatic glands belonging to the female urogenital sinus nor did he make any attempt to find the possible equivalents of the small sinus glands of Littre.

In 1892, Nagel made a careful study of the development of the urethra and perineum of both sexes but his work deals with the early embryonic stages before the glands have developed. He shows correctly, however, the relations of the urethra to the urogenital sinus in the two sexes.

Pallin (1901) correctly concluded that the glands of the female urethra found along its lower portion are homologous not with the whole prostate but only with the cranial and ventral anlage of this organ; that they are not homologous with those prostatic glands belonging to the male urogenital sinus.

In 1911, Evatt modeled the urethra and urethral glands of a three and one-half months old human fetus but did not include any portion of the urogenital sinus. He concluded that those glands "surrounding the whole length of the female urethra are the homologue of the prostate in the male." He is in error, however, when he adds "this indicates that the female urethra is the counterpart of the whole of the prostatic urethra in the male."

The female prostatic glands are dealt with very summarily by Felix in Keibel and Mall's *Manual of Human Embryology*: "In the female few glands are formed. I have found as a maximal number only three; they may undergo development and are then known as the para-urethral or Skene's ducts."

OBSERVATIONS

As I have shown in a previous paper (Johnson, 1920), the beginnings of the prostatic glands are clearly seen in a male embryo of 55 mm. when as many as twenty-six gland buds are present. Lowsley (1912) reports their absence in an embryo of 50 mm. but finds that they are numerous at 75 mm. They are situated on all sides of the urethra both above and below

the junction of this structure with the fused Müllerian ducts. In other words, they belong in part to the true urethra and in part to the urogenital sinus. In the male, as shown by Lichtenberg (1906), Lowsley (1912), and myself, the greater number of tubules arise from the urogenital sinus. It is to be noted, however, that in the male the true urethra remains very short and that the available space for glands to arise from it is correspondingly small.

In a female embryo of a corresponding period of development (60 mm.) it is noted that the true urethra is relatively longer, the fused Müllerian ducts or utero-vaginal canal larger, the Wolffian ducts largely degenerated and the urogenital sinus relatively shorter and broader than in the male (fig. 7). Glands which are totally absent in a female embryo of 43 mm. are now present in considerable numbers. They are situated both along the true urethra and at the proximal end of the urogenital sinus. Contrary, however, to the arrangement found in the male the majority of glands belong to the true urethra. Careful examination of the model shown in figure 7 shows that the gland buds are found on the anterior, lateral and posterior surfaces of the urethra and in this respect correspond exactly to the arrangement found in the male. Their structure is likewise similar to that of the male; i.e., they are rounded, solid, epithelial growths which extend into the surrounding mesenchyme, the majority being directed toward the bladder. An actual count of the gland buds at this stage (60 mm.) shows fourteen belonging to the urethra and five to the urogenital sinus.

Further comparison of this model with that of the corresponding stage in the male brings out a number of important points. The fused Müllerian ducts or utero-vaginal canal is a well defined ribbon-like duct as compared to the much smaller rounded duct in the male. The urogenital sinus which is a long and narrow tube in the male has become relatively shorter and broader in the female. In both sexes it begins at the junction of the true urethra and the utero-vaginal canal and terminates anteriorly in the "sinus plate" in the phallus. Its epithelium is thrown into a number of folds. Of these there can be distin-

guished a well-marked dorsal fold corresponding very closely to the verumontanum, two lateral folds on each side and a deep fold on the anterior wall which is divided into two by a thin, low ridge of epithelium. This ridge of epithelium terminates anteriorly in the clitoris and corresponds to the misnamed "urethral plate" in the male. In the present paper I have termed it the "sinus plate" which to me appears more appropriate for both sexes.

Situated on each lateral wall of the urogenital sinus nearer to its dorsal than ventral surface are two tubular, blind ducts. These are the major vestibular glands (Bartholin's) which, as is well known, correspond in position and structure with the bulbo-urethral (Cowper's) glands of the male but they are somewhat smaller in size. In marked contrast to the male, however, is the elongated orifice of the urogenital sinus which in the male has largely closed. The clitoris except for its slightly smaller size, is essentially similar to the penis of the male and shows an homologous glandar lamella, the beginning of the prepuce.

In an embryo of 75 mm. the urethral glands are more numerous and larger than in the preceding stage (fig. 8). Again they are found on both the urethra and on the urogenital sinus and a few are found on the utero-vaginal canal at its lower end. They are still solid epithelial processes (fig. 1, B and C) and the majority of them point towards the bladder. In all there is a total of twenty-six glands. The true urethra is considerably longer than that of the male of a corresponding stage. It is joined by the ribbon-shaped utero-vaginal canal which parallels it dorsally in the pelvic mesenchyme (fig. 1, C). The urogenital sinus, which is again relatively broad and short, presents a number of large folds which roughly correspond with those of the male. There can be distinguished dorsal, ventral and lateral folds, the dorsal being the equivalent of the verumontanum. Bartholin's glands at this stage are present as small branched tubular glands, the ducts of which spring from the lateral folds of the urogenital sinus at approximately midway between its two extremities.

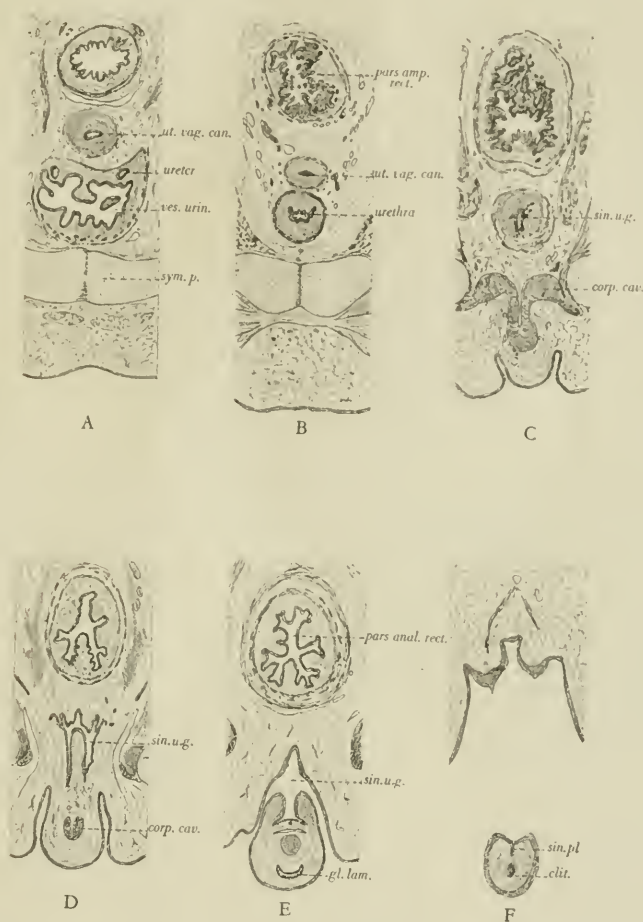


FIG. 1. SIX SUCCESSIVE TRANSVERSE SECTIONS OF THE PELVIS OF A FEMALE EMBRYO OF 75 MM. CROWN-RUMP LENGTH. $\times 12$ DIAMETERS

The junction of the urethra and the utero-vaginal canal is seen in C. The orifice of the urogenital sinus is shown in figures E and F. The anal orifice is seen in figure F.

On the dorsum of the urogenital sinus are to be seen five small simple tubular glands (fig. 8) still in the solid stage. These glands correspond definitely with the small sinus (Littre) glands of the male and are destined to become the smaller vestibular glands of the female vulva. The clitoris is still relatively large and is directed analward as pointed out by Spaulding (1921). Its glandar lamella is changing its position and direction as does that of the male (Johnson, 1920).

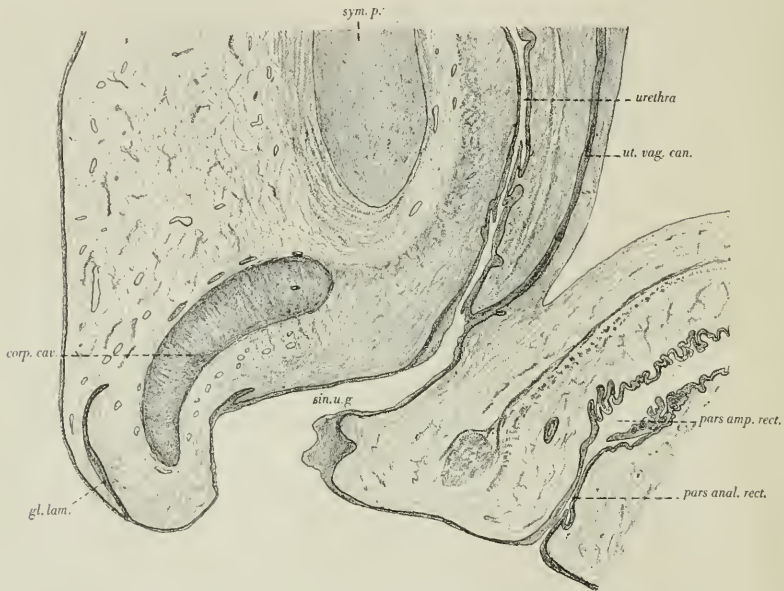


FIG. 2. MID-SAGITTAL SECTION OF THE PELVIS OF A FEMALE EMBRYO OF 80 MM.
× 12 DIAMETERS

The upper part of the section is taken through the vesical neck but there is no sharp demarcation between this structure and the urethra. The utero-vaginal canal is seen as a solid cord of cells which joins the urethra to form the urogenital sinus. A few glands are seen along the urethra but none is present in the urogenital sinus. The glandar lamella, the forerunner of the prepuce, is clearly shown in the clitoris.

A mid-sagittal section of the pelvis of an 80 mm. female embryo is shown in figure 2. A few prostatic glands are seen along the urethra and one at the lower extremity of the utero-vaginal

canal. The urogenital sinus, formed by the union of the urethra and utero-vaginal canal is again relatively short as compared with that of the male. No glands are seen belonging to the urogenital sinus in the mid-sagittal section but a few are found in the adjacent sections. The wide-open orifice of the sinus, bounded anteriorly by the clitoris and posteriorly by the perineum, is in marked contrast to the closed condition found in the male at this stage. The clitoris is again directed downward and the glandar lamella is well developed. The corpus cavernosum of the clitoris is now well differentiated from the mesenchyme and is quite similar to that of the penis in the corresponding stage.

A number of important changes are to be noted in the urogenital structures of a female fetus of 150 mm. The urethra has increased markedly in diameter and is flattened in a dorso-ventral direction. Its epithelium is thrown into a number of large folds corresponding to the primary folds of the male urethra. Glands are found throughout its course, more highly developed, however, in its distal one-half. They are longer than in the previously described stage and a few of them show branches and lumina.

The utero-vaginal canal has undergone a marked enlargement and its distal portion has taken on the characteristics of the vagina. Whereas in the early stages it is represented as a narrow ribbon-like strand of epithelial cells, at 150 mm. it is a large rounded tube. Its epithelium, which is thrown into a number of large folds, is of the stratified squamous type. Numerous desquamated cells fill the rather small lumen. The urogenital sinus is again shorter and broader than in the preceding stages. It is lined with a stratified squamous epithelium which is much thinner than that of the vagina.

In addition to Bartholin's glands, which are now branched tubular glands of considerable size, the urogenital sinus possesses a few glands similar to the urethral glands which are found close to the orifice of the urethra. There are also present a few small tubular glands distal to the origin of Bartholin's glands, which from their position are easily recognized as the small sinus glands.

Cross sections of the urethra of a human female fetus of 176 mm. shows in its upper part a single large infolding of the mucous membrane on the dorsal surface. In addition are two large folds ventrally and several smaller ones on the lateral surfaces. Extending outward into the mesenchyme from the furrows between the folds are a number of small bud-like glands which for the most part are devoid of branches. A model of this portion of the urethra showing a few of the glands is shown in figure 9, B. It will be noticed that the longer glands have a tendency to point bladderward. The epithelium of the urethra in this part is stratified squamous of two to four layers of cells in thickness.

As the urethra is followed distally it becomes flattened dorso-ventrally, possessing a slight concavity on its dorsal surface (fig. 9, A). The folds become more and more irregular, the glands longer and more branched. Lumina appear which in the glands of the lower urethra extend into the terminal branches. The glands bend at right angles and course parallel to the urethra. In most instances, though not invariably, they are directed bladderward. The extreme lower end of the urethra is more rounded in form, is without definite folds and its glands are few and small.

The vagina is greatly enlarged having a diameter seven to eight times that of the urethra. Its mucosa is thrown in five to six large folds with smaller ones between them. The epithelium possesses fifteen to thirty layers of cells in thickness. Its lumen is relatively small and contains small masses of desquamated epithelial cells. At the external vaginal orifice the large folds terminate abruptly. They apparently play an important part in the formation of the hymen. No glands are found arising from the vaginal epithelium.

The urogenital sinus is reduced to a narrow slit-like cavity which lies between the folds of the labia minora. It is lined by a rather thin stratified squamous epithelium of from five to twelve layers in thickness. Extending orally from the posterior portion of the urogenital sinus are seen the two large patent ducts of Bartholin's glands (fig. 3). They divide into numerous

branches and the gland bodies lie in the connective tissue lateral to the lower portion of the vagina. In addition to Bartholin's glands are seen six small rather rudimentary glands arising from the rectal wall of the urogenital sinus and three from its pubic wall. These are simple tubular glands, unbranched, and the larger ones possess definite lumina. The largest one has its origin in the midline, the remainder laterally (fig. 3).

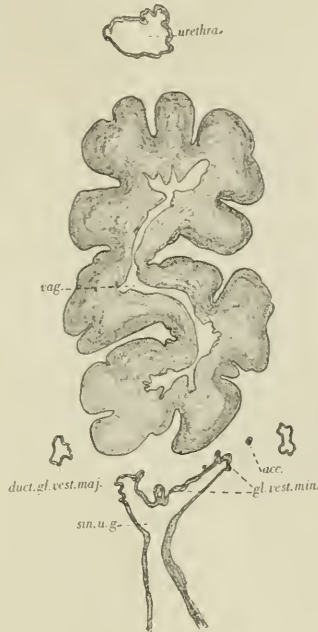


FIG. 3. FRONTAL SECTION OF THE PELVIC STRUCTURES OF A FEMALE FETUS OF 176 MM.

The section is taken close to the urethral and vaginal orifices. Only the epithelial structures are shown in the drawing. An enormously thickened stratified squamous epithelium of the vagina, as contrasted to the epithelium of the urethra and urogenital sinus, is clearly shown.

Worthy of mention is a small gland arising close to Bartholin's on the left side and paralleling its duct. This is similar to Bartholin's gland except that it is smaller; I have interpreted it as an accessory Bartholin's gland corresponding with the occasional accessory Cowper's gland found in the male (Lichtenberg, Johnson).

Sections of the urethrae of fetuses of 215 and 275 mm. show in addition to growth changes in the structures already noted a few points of interest. The urethral glands in both of these stages extend all the way down to the orifice of the urethra. In the 275 mm. stage several glands are found just outside the orifice belonging, therefore, to the urogenital sinus. Two of these, larger than the others, are placed one on either side of the orifice (fig. 4). They divide into several branches and are lined with a stratified epithelium which is in places cuboidal in type; in other places it is stratified squamous. Like those



FIG. 4. CROSS SECTION OF THE URETHRA OF A FEMALE FETUS OF 275 MM. $\times 26$ DIAMETERS

The section passes just above the orifice of the urethra and shows Skene's ducts as well as urethral glands, both of which are homologues of the prostate.

glands of the urethra they possess no cells which appear to be in an active state of secretion. These glands conform in position to the para-urethral ducts of Skene and their origin as prostatic ducts belonging to the urogenital sinus cannot be doubted.

In order to study the urethral glands of the adult a female urethra was dissected free from the adjoining structures, fixed in formalin and cut transversely into segments. The segments were then imbedded and sectioned for microscopic study. The important points which these sections show relative to the present work may be briefly summarized as follows: In the region of

the vesical orifice and upper third the urethra is flattened dorso-ventrally into a transverse slit. The mucosa is thrown into a number of small irregular longitudinal folds. The epithelium is stratified columnar in type and composed of from six to eight layers of cells. A few short simple tubular ducts or glands are present. They lie close to the urethral epithelium penetrating the submucosa but for a short distance. They are lined with a thick stratified cuboidal epithelium but the cells show no evidence of active secretion. The lumina of the glands are very small compared to the diameters of the glands.

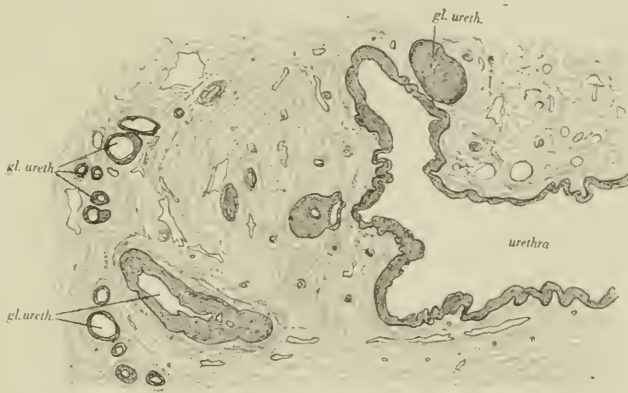


FIG. 5. A PORTION OF THE URETHRA AND A FEW URETHRAL GLANDS OF AN ADULT FEMALE. $\times 26$ DIAMETERS

The drawing shows merely the lateral wall of the urethra and its mucous membrane. The glands are characterized by thickened walls and very small lumina.

In the middle third the urethra has tapered down in size but is still flattened dorso-ventrally (fig. 5). The mucosal folds are somewhat larger but still irregular in form. The epithelium is of the same type as above but thinner and contains fewer layers of cells. Glands are more numerous, longer and more branched and penetrate the submucosa for a greater distance. Their ducts are characterized by having thick epithelial walls and very small lumina; in some lumina are absent. The lumina of the branches are relatively larger. They are lined with a cuboidal epithelium of one to three layers in thickness.

In the lower third the urethra is still smaller in diameter, the folds larger and the glands again more numerous and more branched. The glands have, however, the same characteristics; thick-walled ducts, small lumina, and an apparent lack of secreting cells.

SUMMARY

The urethra of the female corresponds with that portion of the male urethra which lies between the vesical orifice and the prostatic utricle. The shallow vestibule of the female is the corresponding equivalent of that portion of the male urethra between the prostatic utricle and the external urinary orifice. In the embryonic and fetal stages the urogenital sinus of the male grows chiefly in length; in the female it grows chiefly in breadth (dorso-ventrally).

Coincident with the formation of prostatic glands in the male there appear similar glands in the female. These are first seen in embryos of about 60 mm. in length. They are distributed along the whole of the urethra on its anterior, posterior and lateral walls. Some arise from the proximal end of the urogenital sinus and a few from the distal end of the utero-vaginal canal. The latter evidently degenerate for they are absent in the later fetal stages and in the adult. At first few and small the urethral glands gradually increase in number and size and give rise to branches. Their growth, however, is markedly retarded as compared with those of the male and they never attain as high a degree of development as the male prostatic glands. In the adult their only points of similarity with the prostatic glands are their relations to the urethra and urethral mucosa, that they are branched tubular glands, and that they are directed bladderward. They differ from the prostatic glands in that they are fewer in number, less closely packed together, have fewer branches, thicker epithelial walls, smaller lumina, and their epithelia show less evidence of active secretion.

In marked contrast to the condition found in the male the number of "prostatic" glands belonging to the female urogenital sinus is small. In the late fetal stages and in the adult their

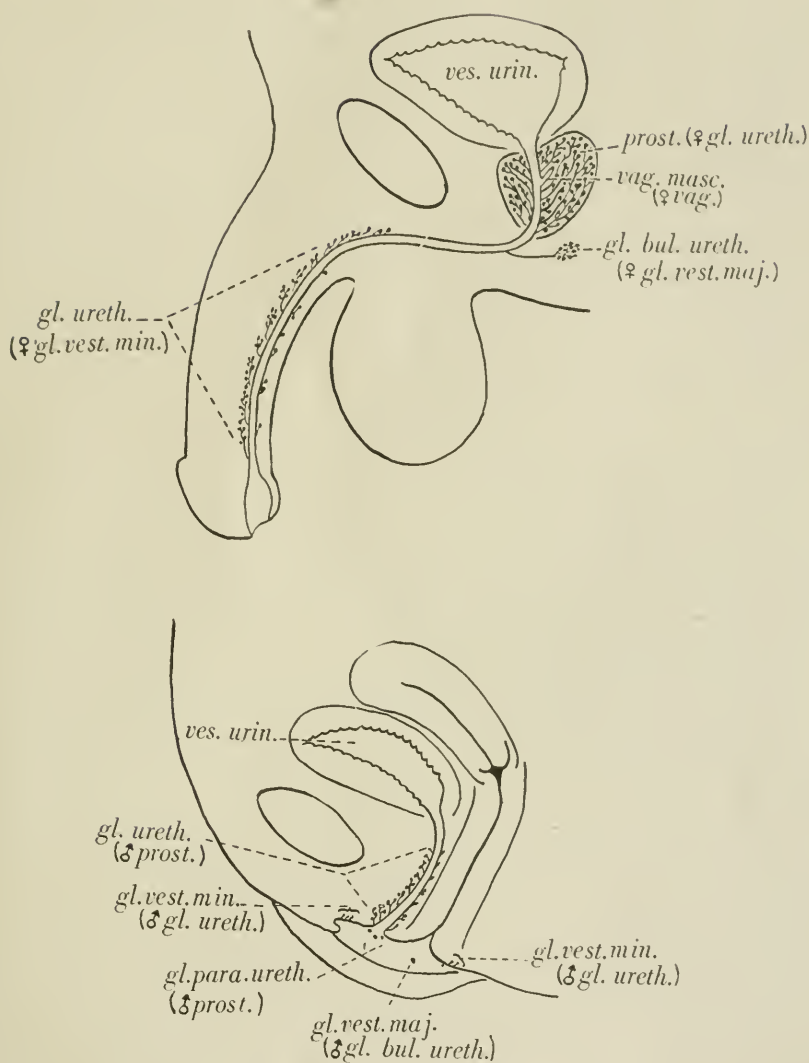


FIG. 6. DIAGRAM SHOWING HOMOLOGOUS GLANDS OF MALE AND FEMALE UROGENITAL TRACTS

The corresponding homologue in the opposite sex is denoted in the parentheses

ducts are found in the immediate vicinity of the external urinary orifice. The larger of these are unquestionably those which bear the names of para-urethral or Skene's ducts.

The major vestibular and bulbo-urethral glands appear in embryos of the same age. They are branched tubular glands, their ducts emptying into the lateral walls of the urogenital sinus. In the male the ducts become much longer than in the female but otherwise they are essentially similar histologically. It is of interest that accessory Bartholin's glands may be present which correspond to the occasionally present accessory Cowper's gland.

The small glands of the urogenital sinus which are so numerous and highly developed in the male are but poorly represented in the female. They are located on both the pubic and rectal surfaces of the urogenital sinus corresponding in this respect to the position of those found in the male. In the later fetal stages they are represented by short gland buds or tubular structures and show no evidence of secretory activity, whereas in the male their homologues (Littre's glands) are large, actively secreting, branched tubular glands.

Tabulation of homologies demonstrated by this investigation

MALE	FEMALE
Urethra.....	{ Urethra Vestibule
Prostate.....	{ Urethral glands Para-urethral ducts
Cowper's glands.....	Bartholin's glands
Littre's glands.....	Minor vestibular glands

CONCLUSIONS

1. The urethra of the female corresponds only with that portion of the prostatic urethra of the male which lies between the internal urethral orifice and the orifice of the prostatic utricle. The remainder of the male urethra is represented in the female by the vestibule.

2. The whole homologue of the prostate in the female is here demonstrated for the first time. It consists of:

a. The urethral glands which are the homologues of those prostatic glands in the male which lie above the orifice of the prostatic utricle (therefore true urethral glands).

b. Skene's ducts which are the homologues of the prostatic glands which lie below the orifice of the prostatic utricle (therefore sinus glands).

3. Bartholin's and Cowper's glands are true homologues.

4. It is also demonstrated for the first time that the glands of Littre are represented in the female by a few poorly developed glands which have received the name "minor vestibular glands."

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ABBREVIATIONS

<i>acc.</i> , accessory Bartholin's gland	<i>gl. vest. maj.</i> , major vestibular glands
<i>clit.</i> , clitoris	<i>gl. vest. min.</i> , minor vestibular glands
<i>corp cav.</i> , corpus cavernosum of the clitoris	<i>pars amp. rect.</i> , pars ampularis recti
<i>duct. mes.</i> , Wolffian duct	<i>pars anal. rect.</i> , pars analis recti
<i>gl. bul. ureth.</i> , bulbo-urethral or Cowper's gland	<i>prost.</i> , prostate
<i>gl. lam.</i> , glandar lamella	<i>sin. pl.</i> , sinus plate
<i>gl. para-ureth.</i> , para-urethral or Skene's glands	<i>sin. u. g.</i> , urogenital sinus
<i>gl. ureth.</i> , urethral glands	<i>sym. p.</i> , symphysis pubis
	<i>vag.</i> , vagina
	<i>ves. urin.</i> , urinary bladder
	<i>ut. vag. can.</i> , utero-vaginal canal

PLATE 1

FIG. 7. Lateral view of a wax reconstruction of the urethra and associated epithelial structures of a female embryo of 60 mm. \times 33 diameters. The right half of the clitoris has been dissected away, showing a concavity filled with mesenchymal tissues. The urogenital sinus is much shorter but broader than in the corresponding stage of the male. Its only glands are the major vestibular or Bartholin's glands, the homologues of Cowper's. At the junction of the utero-vaginal canal and urethra is seen the distal remnant of the Wolffian duct (*duct. mes.*). The urethra shows numerous glands which are true homologues of the prostatic glands. A few of these glands are also found at the junction of the urethra and utero-vaginal canal.



PLATE 2

FIG. 8. Lateral view of a wax reconstruction of the urethra and associated epithelial structures of a female embryo of 75 mm. \times ca. 18 diameters. The urethral glands have increased in size but are still unbranched. Bartholin's glands, however, now show several branches. In addition, the urogenital sinus shows on its dorsal surface five small epithelial buds, the beginnings of the minor vestibular glands. These glands are represented in the male by the glands of Littre. The glandar lamella is again prominent and is seen to be shifting its position in a similar manner to that of the male.

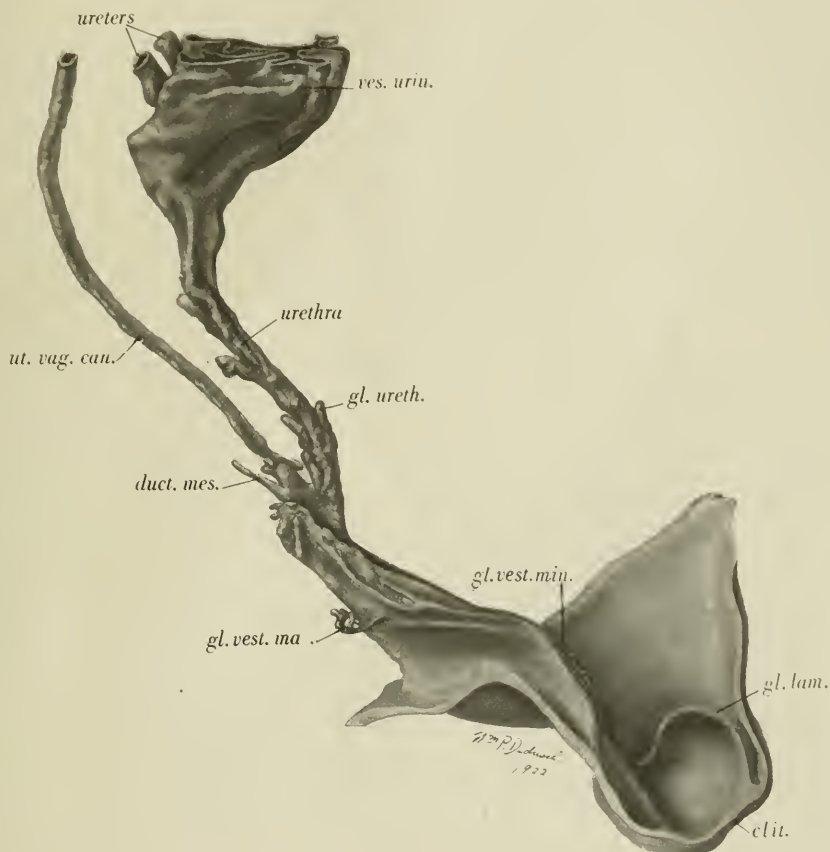


PLATE 3

FIG 9. Wax reconstructions of two segments of the urethra of a female fetus of 176 mm. a, distal portion; b, proximal portion. $\times 50$ diameters. The glands of the lower portion of the urethra are seen to be much longer and more branched than those in the upper portion. Like the prostatic glands in the male these urethral glands, which are their homologues, course parallel to the long axis of the urethra and their blind ends are directed bladderward.



A



B

THE CLINICAL VALUE OF MERCUROPHEN IN THE TREATMENT OF GONOCOCCAL URETHRITIS¹

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Sodium oxy-mercury-ortho-nitro phenolate is a new mercurial germicide introduced by Schamberg, Kolmer and Raiziss (1) and designated by them as "mercurophen." These investigators have studied its biological properties in an exhaustive manner with special reference to its value as a disinfectant (2). The substance occurs as a brick red powder, contains approximately 53 per cent mercury and can be moulded into tablets. These tablets are readily soluble in hot water, giving a deep amber colored solution.

The writer has employed mercurophen in the treatment of acute and chronic gonorrheal urethritis with very gratifying results (3) and the purpose of the present communication is to record further experiences with it in the treatment of a series of cases of this disease.

This drug is well tolerated and effective in the urethra when used in dilutions of 1:4000 to 1:10,000; the latter strength more especially for total irrigations. After these injections the patient often complains of some burning in the fossa navicularis or perineum, with frequency of urination if the medicine has been given beyond the cut off muscle. This condition may last from fifteen minutes to one hour (very rarely for a longer period), depending on the strength of the solution used and the output of water following its administration.

In acute gonorrheal urethritis the injection of mercurophen is preceded by an irrigation of the anterior urethra of a warm 1:8000 potassium permanganate solution. This cleanses the parts and dissolves the plugs of mucus in the mouths of the

¹ Read before the Philadelphia Urological Society, November 28, 1921.

glands. One or two drams of a 1:4000 solution of mercurophen is then carefully injected and held in the anterior urethra for five minutes. The patient is then given a 1:9000 or 1:10,000 solution of mercurophen for home use. He is instructed to use a blunt nose glass syringe, with a bulb tip, holding about 2 drams. These injections are to be taken following every other urination and retained in the urethra for at least five minutes.

If the irritation from these injections lasts more than a few minutes the number taken should be reduced to two or three times a day, following urination. The number of treatments given in the table are those administered by the physician; no record was kept of the number of home treatments. The urethral smears were examined and recorded each day the patient reported for treatment. As the number of organisms decrease, with an increase in the epithelial cells, the number of daily injections of mercurophen should be decreased as well as the number of office treatments which at first should be every day. The drug is gradually reduced and finally discontinued and any remaining catarrhal process in the urethra is treated with irrigations of potassium permanganate or some other more effective astringent. The average number of treatments given in this group were $4\frac{3}{5}$. There were nineteen of the acute cases where the infection was apparently confined to the anterior urethra. In this series a case was considered cured when the discharge and urine cleared up.

The cases of acute urethritis responded well to treatment, especially those cases that carried out the directions carefully in regard to home treatment. The method used in determining improvement has been a microscopic examination of the urethral smears counting the number of infected cells per field, using the high power, and taking the average of the number counted in from three to twenty fields (due to some error in the laboratory, ten fields were not counted in all smears as we had originally intended doing). The second smear was generally taken twenty-four hours following the first. There were only three cases in this group that did not show a decrease in the number of infected cells per field in the second smear. The two glass test was used

to determine the part of the urethra involved and the extent of involvement. The examination of the prostate and vesicles was not made in the acute cases until the discharge and urines cleared up; also at this time the urethra was examined for stricture. If infection or obstruction were found they were treated accordingly. The majority of cases discontinued their treatment after cessation of the urethral discharge.

The minimum number of days to free the discharge from gonococci was one; the maximum one hundred and twenty. In the latter case the patient reported very irregularly for treatment and did not carry out the directions given for home treatment. The urethral discharge in some cases was entirely stopped in twenty-four hours after the first injection; other cases took longer, the maximum number being 125 days; the average $11\frac{3}{4}$. Nine of the acute cases did not receive more than one treatment; and two did not return regularly for treatment. Six of the acute cases developed epididymitis after treatment was started. One case reported with a peri-urethral abscess; another had multiple strictures of the anterior urethra due to a previous infection. Seven cases had a recurrence of the urethral discharge, where gonococci were found. These were due mostly to a reinfection from the prostate gland. Most of these cases stopped treatment as soon as the urethral discharge disappeared and returned for further treatment at the reappearance of the same. Three of the acute showed no gonococci; these responded promptly to treatment.

The patients with exacerbations of urethritis were treated in the same manner as the acute cases until the acute symptoms subsided, when treatment to the posterior urethra was instituted. All of this group had infection of the entire urethra; two had infection of the seminal vesicles. Total irrigations were given to the urethra with a warm 1:8000 solution of potassium permanganate; this the patient voided immediately, and then from one to two ounces of mercurophen 1:4000 was gently forced into the posterior urethra by means of a bulb syringe and retained in the bladder for half an hour or longer. On voiding this solution there was a transient burning in most cases, with a

	NUMBER OF CASE																
	63 ¹⁷	64	65	66 ¹³	67 ¹⁹	91 ²⁰	92	71	72	97 ²¹	98	99 ²²	103 ²³	15	5	4	
Age, years.....	23	38	26	29	—	22	18	20	22	17	24	30	25	26	20	45	19
Previous attacks.....	0	0	0	0	0	0	0	1	1	0	1	0	0	2	0	3	0
Days of disease.....	3	2	1	18	21	2	5	7	7	1	4	180	7	28	21	15	14
Anterior urethritis.....	+	+	+	+	+	+	+	+	0	+	0	+	+	+	+	+	+
Anterior and posterior urethritis.....	+	0	0	+	+	+	0	+	+	+	+	0	0	0	+	+	+
Number of infected cells per field H. P., first smear.....	5	2	3	0	8	3	3	3	3	0	2	0	0	3	3	1 ¹⁰	3
Number of infected cells per field H. P., second smear.....	2 ¹	0	2 ⁸	2 ⁸	0	0	3	3	0	0	0	0	0	3 ¹⁰	1	0	0
Number of days to free smear from gonococci.....	2	1	7	5	1	10	4	7	1	0	1	0	0	7	4	2	1
Number of days to stop urethral discharge.....	3	1	15	5	1	15	5	8	2	3	7	5	5	20	5	4	2
Number of treatments given.....	2	1	7	4	1	2	2	6	1	2	5	2	2	7	3	2	2
Strength of solution.....	1:4000	1:4000	1:4000	1:9000	1:4000	1:4000	1:8000	1:4000	1:4000	1:5000	1:8000	1:8000	1:8000	1:5000	1:6000	1:4000	1:4000
Complications.....	0	0	0	+	0	+	0	0	0	0	0	0	0	0	0	0	0

¹ Did not return for treatment.² Returned for two treatments only.³ Received only two treatments.⁴ Did not come regular for treatment.⁵ Epididymitis and recurrence of discharge.⁶ Did not carry out directions or report regular for treatment.⁷ Recurrence eight months later due to prostatitis.⁸ Epididymitis on the seventeenth day.⁹ Recurrence of discharge on the fourth day. Epididymitis on the sixtieth day.¹⁰ Recurrence of discharge due to prostatitis.¹¹ Recurrence of discharge due to prostatitis. Reported irregular.¹² Epididymitis on the twenty-fourth day.¹³ Epididymitis on the twenty-fourth day.¹⁴ Did not return for further treatment.¹⁵ Recurrence of discharge due to prostatitis.¹⁶ Multiple strictures anterior urethra.¹⁷ Recurrence of urethral discharge on fourth day. Stopped on tenth day.¹⁸ Peri-urethral infection with recurrence of morning drop on tenth day.¹⁹ Recurrence of discharge thirty days later due to prostatitis.²⁰ Epididymitis on twenty-fifth day. Had not reported since fifteenth day.²¹ Mixed infection, no gonococci found.²² Mixed infection, no gonococci found.²³ Mixed infection, no gonococci found.

TABLE 2
Clinical results of the use of mercuraphen in chronic gonorrhea with acute exacerbations of urethritis

	NUMBER OF CASE									
	100 ¹	101	55 ²	20 ³	18 ⁴	14	2	90	109	
Age, years.....	23	29	21	23	37	28	28	21	28	
Previous attacks.....	1	3	1	1	3	2	3	2	2	
Number of days duration of present attack.	2	3	2	12	2	3	7	4	3	
Extent of involvement:										
Anterior urethritis.....	+	+	+	+	+	+	+	+	+	
Anterior and posterior urethritis.....	+	+	+	+	+	+	+	+	+	
Prostatitis.....	+	+	+	+	+	+	+	+	+	
Seminal vesiculitis.....	+	+	0	0	0	0	0	0	0	
Number of infected cells per field H. P., first smear.....	2	5	3	1	4	2	2	$\frac{8}{5}$	$\frac{1}{6}$	
Number of infected cells per field H. P., second smear.....	0	$\frac{2}{6}$	0	0	$\frac{1}{11}$	0	0	2	0	
Number of days to free smear from gonococci.....	2	16	1	4	0	1	2	8	2	
Number of days to stop urethral discharge.	4	37	1	14	0	3	2	10	2	
Number of treatments.....	1	11	1	4	5	2	1	4	1	
Strength of solution.....	1:10000	1:9000	1:10000	1:10000	1:5000	1:8000	1:4000	1:4000	1:4000	
Complications.....	0	0	0	0	0	0	0	0	0	

¹ Recurrence of discharge on thirtieth day due to prostatitis and vesiculitis.

² Recurrence of discharge 8 months later due to prostatitis.

³ Recurrence of discharge due to prostatitis.

⁴ Did not complete treatment.

TABLE 3

Clinical results of the use of mercurophen in chronic gonorrheal urethritis

	NUMBER OF CASE									
	102	103	101 ¹	105	106 ²	108 ³	110 ⁴	111 ⁵	112 ⁷	
Age, years.....	22	34	18	24	38	23	19	25	24	
Previous attacks.....	2	1	1	0	2	0	0	0	1	
Duration of present attack.....	10 months	6 weeks	15 years	1 year	5 years	5 months	4 months	2 years	3 months	
Extent of involvement:										
Anterior urethritis.....	+	+	+	+	+	+	+	+	+	
Anterior and posterior urethritis.....	+	+	+	+	+	+	+	+	+	
Prostatitis.....	+	+	+	+	+	+	+	+	+	
Seminal vesiculitis.....	0	0	0	+	+	0	0	0	0	
Number of infected cells per field H. P., first smear.....	0	0	0	0	0	0	0	0	0	
Number of infected cells per field H. P., second smear.....	0	0	0	0	0	0	0	0	0	
Number of treatments given to stop urethral discharge and clear urine.....	0	0	0	0	0	0	0	0	0	
Strength of solution.....	6	2	2	10	1	1	1	2	4	
Complications.....	1:10000 0	1:10000 0	1:5000 +	1:10000 0	1:10000 +	1:10000 0	1:8000 0	1:9000 0	1:10000 0	

	NUMBER OF CASE									
	113 ⁸	89	88	86 ⁹	85	83	82	81	78 ¹⁰	76 ¹¹
Age, years.....	32	17	25	27	35	46	37	29	32	33
Previous attacks.....	1	1	2	0	1	9	2	1	1	1
Duration of present attack.....	1 month	7 weeks	8 weeks	3 months	4 months	2 years	4 months	9 weeks	3 months	6 months
Extent of involvement:										
Anterior urethritis.....	+	+	+	+	+	+	+	+	+	+
Anterior and posterior urethritis.....	+	+	+	+	+	+	+	+	+	+
Prostatitis.....	+	+	+	+	+	+	+	+	+	+
Seminal vesiculitis.....	+	0	0	0	0	0	+	0	0	0
Number of infected cells per field H. P., first smear.....	0	1 $\frac{1}{2}$	0	1	0	0	1 $\frac{1}{2}$	0	0	0
Number of infected cells per field H. P., second smear.....	0	0	0	0	0	0	0	0	0	0
Number of treatments given to stop urethral discharge and clear urine.....	1	7	1	1	10	6	9	5	1	5
Strength of solution.....	1:4000	1:4000	1:8000	1:8000	1:9000	1:5000 1:8000	1:5000	1:5000	1:18000	1:4000 1:8000
Complications.....	0	0	0	+	0	0	0	0	0	0

¹ Stricture of bulbous urethra. Previously on Potassium permanganate and argyrol.

² Stricture of bulbous urethra. Previously on Potassium permanganate and argyrol.

³ Previously on Potassium permanganate and argyrol.

⁴ Previously on Potassium permanganate and argyrol.

⁵ Previously on Potassium permanganate and argyrol.

⁶ Previously on Potassium permanganate and argyrol.

⁷ Previously on Potassium permanganate and argyrol.

⁸ Recurrence of hazy urines. Previously on Potassium permanganate and argyrol.

⁹ Epididymitis thirty days following first treatment.

¹⁰ Previously on Potassium permanganate and argyrol.

¹¹ Previously on Potassium permanganate and argyrol.

TABLE 4
Synopsis of results detailed in tables 1, 2 and 3

Number of cases studied.....	80
(A) Acute cases.....	51
(B) Acute exacerbations.....	9
(C) Chronic cases.....	20
Number of cases under observation until an apparent cure was affected:	
(A) Acute cases.....	35
(B) Acute exacerbations.....	5
(C) Chronic cases.....	19
Number of cases failing to improve:	
(A) Acute cases.....	0
(B) Acute exacerbations.....	0
(C) Chronic cases.....	0
Minimum time required to render discharge gonococcus-free:	
(A) Acute cases.....	1 day
(B) Acute exacerbations.....	1 day
(C) Chronic cases.....	1 day
Maximum time required to render discharge gonococcus-free:	
(A) Acute cases.....	120 days
(B) Acute exacerbations.....	16 days
(C) Chronic cases.....	1 day
The average time to render the discharge gonococcus-free:	
(A) Acute cases.....	9½ days
(B) Acute exacerbations.....	4½ days
(C) Chronic cases.....	1 day
Number of cases in which complications developed after treatment was started:	
(A) Acute cases.....	6
(B) Acute exacerbations.....	0
(C) Chronic cases.....	1
Average number of days to stop urethral discharge:	
(A) Acute cases.....	11½
(B) Acute exacerbations.....	9½
(C) Chronic cases.....	3½
Average number of treatments given by physician:	
(A) Acute cases.....	4½
(B) Acute exacerbations.....	3½
(C) Chronic cases.....	3½

slight amount of frequency, which passed off in from fifteen minutes to half an hour. These cases where treatment was given to the posterior urethra, received on the average of two treatments a week. There were three recurrences of urethral discharge in this group, where the smears were positive, due in each to a pre-existing prostatitis. The minimum time to render the discharge gonococcus free was one day; the maximum sixteen; the average four and one half days. There was no urethral discharge in the average case after $9\frac{1}{8}$ days. The number of treatments given by the physician averaged $3\frac{1}{3}$. The duration of the prostatic or vesicular infection is not included in this paper. There were no complications and the recurrences responded promptly to treatment.

In the last or chronic group there were twenty cases, all of which showed infection of the entire urethra, with prostatic involvement in all, and infection of the seminal vesicles in four. Two had strictures of the bulbous urethra; one developed epididymitis thirty days after treatment was started. Eight of these cases had previously been on total irrigations of potassium permanganate solution (increasing strength), and instillations of a 10 per cent solution of argyrol to the deep urethra for a period of a few weeks to many months. They showed very little improvement during that time. Most all in this lot had a morning drop, or a scant urethral discharge during the day, with hazy urines. In only four cases were gonococci found. The number of treatments given in table three included those necessary to stop the urethral discharge and clear the urines. The time necessary to cure the infections of the prostate and vesicles or to dilate the urethral strictures is not included. The average number of treatments given were $3\frac{1}{2}$. The method used was the same as in the acute exacerbations.

It might be well to mention here that after the first dilatation of urethral strictures the instillation in the deep urethra of 20 to 30 drops of 1:4000 mercuriophen prevented urethral chills, which are not uncommon in stricture cases after their first treatment.

REPORT OF CASES

Included in this report are two cases that are not due to a gonorrheal infection; one a case of colon bacillus infection of the bladder; the other tuberculosis of the bladder secondary to infection of the left kidney and ureter.

1. *Case 2a* (not included in the chart). Female, age fifty-eight. Venereal history negative. Diagnosis, cystitis. Laboratory report on the urine showed the presence of colon bacilli. Both kidneys negative.

Treatment was started on July 27, 1921, which consisted of irrigating the bladder with sterile water: following this the introduction of one ounce of mercurochrome 220 (freshly prepared) 1 per cent solution. The patient retaining the drug for one hour. This treatment was given every other day for one week, with very little improvement. Mercurophen was then substituted for mercurochrome 220, using first a 1:9000 solution and on the second visit increasing to 1:4000. Two days following the use of mercurophen there was great improvement in the clinical symptoms and urine. Four days following the urine report from the laboratory was negative, with a disappearance of all symptoms.

2. *Case 1a* (not included in chart). Male, age twenty-eight. Venereal history negative. Diagnosis, tuberculosis of the left kidney, ureter and bladder.

Operation on July 18, 1921. Left kidney and ureter removed; bladder infection treated with mercurochrome 220, beginning with 0.25 per cent (freshly prepared.) These treatments were given three times a week. The bladder was first irrigated with sterile water as in the previous case. The treatments were given from July 29, 1921, to September 12, 1921, with practically no improvement in the urine (the right kidney and ureter were negative), although following the nephrectomy the subjective bladder symptoms improved. The strength of the solution was increased to 1 per cent. On September 16, 1921, mercurophen 1:9000 was substituted; the strength of the solution gradually increased to 1:4000. On October 4, 1921, the urines showed improvement, and on the 18th of the same month they were entirely clear, with the exception of a few shreds. Subjective symptoms negative.

3. *Case 106*. Male, age thirty-eight. Two previous gonorrheal infections, last twelve years ago.

Reported on May 17, 1920, with a filliform stricture of bulbous urethra, chronic urethritis and prostatitis. A morning drop was present; first urine slightly hazy with light and heavy shreds, second clear.

The stricture was dilated until a 32 sound was reached, with total irrigations to the urethra of a 1:8000 to 1:5000 potassium permanganate solution. The prostate received the necessary treatment. It was impossible to entirely clear up the urine. The patient reported regularly for treatment for three months; then irregularly up to February 28, 1921; at that time there was no urethral discharge; the first urine was hazy with light and heavy shreds, the second was slightly hazy with light and heavy shreds. The stricture was well dilated and the prostate massaged and on February 28 a 1:10000 total irrigation of mercuraphen was given. The next visit March 11, 1921, both urines were clear, with a few light shreds in the first. The last time the patient reported for dilatation was on June 10, 1921. There had been no recurrence of hazy urine in the interval.

4. *Case 40.* Male, age thirty-two. Gonorrhea twelve years ago.

Reported on September 26, 1921, with a slight urethral discharge, positive for gonococci; first urine hazy, second clear, twenty-four hours duration; was exposed to infection four days previous. Second visit on September 28, 1921, a slight mucous discharge was present, negative for gonococci; first urine hazy; second clear. Third visit on October 1, 1921. No urethral discharge, patient says discharge stopped following the last treatment. Both urines were clear, first with a few light and heavy shreds. He did not report for further observation.

5. *Case 100.* Male, age twenty-three. Gonorrhea first three months ago.

Reported on December 31, 1920, with a copious urethral discharge, two days duration, positive for gonococci. First and second urines cloudy. Prostatitis and seminal vesiculitis present. Second visit January 5, 1921 no urethral discharge, both urines clear. Recurrence of discharge on the 120th day due to prostatitis and vesiculitis, positive for gonococci. When the patient left on February 9, 1921, there was no discharge and the urines were clear. From that date until April 30, 1921, he received no treatment until the recurrence of the discharge.

6. *Case 2.* Male, age twenty-eight.

First infection at the age of sixteen years; many infections since that time; never free from morning drop. Reported on August 20, 1921, slight urethral discharge; first urine cloudy, second hazy. Chronic prostatitis present. Second visit on August 22, 1921, no urethral discharge; first urine hazy with light and heavy shreds, second clear. On August 30, both urines were clear, first a few light shreds present. Prostatic treatment was continued.

7. *Case 72.* Male, age twenty-two. Gonorrhea two years ago, nothing in interval.

Reported on August 23, 1921, with a moderate urethral discharge, positive for gonococci; first and second urines cloudy. Duration one week; exposed 5 days previous; burning on urination, edema of meatus, pain in left groin. Second visit on August 29, 1921, no urethral discharge, no edema of meatus or pain in groin; first urine cloudy, second hazy. Did not report for further observation.

8. *Case 31.* Male, age eighteen. No previous venereal infection.

Reported on August 8, 1921, with a slight urethral discharge, positive for gonococci; moderate burning during urination: first urine cloudy, second clear. Duration of infection twelve hours; was exposed eight days previous. Second visit August 9, 1921; no subjective symptoms: no urethral discharge and both urines clear; first a few light shreds. No recurrence. Later treated for prostatitis.

9. *Case 93.* Male, age twenty-four. Gonorrhea three times, last in 1920. Nothing seen in the interval.

Reported on March 5, 1921, with a copious urethral discharge, positive for gonococci; first urine cloudy, second clear with a few light and heavy shreds; one month duration. Second visit on March 7. There was a slight mucous discharge; no gonococci; first urine slightly hazy, second clear. Third and last visit on the 12th of the same month, only a small morning drop, no gonococci found. Did not report for further observation.

10. *Case 27.* Male, age 21. No previous venereal infection.

Reported on September 7, 1921, with a slight urethral discharge positive for gonococci. Severe burning on urination; first and second urines cloudy. Duration of infection two days, was exposed one week previous. Second visit on September 8, 1921, no urethral discharge present, first urines slightly hazy, second urine clear. No subjective symptoms. On September 9 there was a slight mucous discharge, gonococci were present; first urine slightly hazy, second clear. This discharge continued until September 17. On September 19 there was just a morning drop. When the patient reported on September 21 there was no discharge and the urines were clear. No recurrence. This patient was later treated for a mild prostatitis.

11. *Case 98.* Male, age twenty-four. Gonorrhea four years ago, nothing since.

Reported on June 13, 1921, duration four days. Exposed to infection six days previous. A slight urethral discharge was present,

positive for gonococci; first and second urines hazy. Second visit on June 14, 1921, no urethral discharge; patient said he had a slight morning drop, first urine hazy, second clear. On the seventh day there was no morning drop and both urines were clear. No gonococci were found in the morning smear. Did not report for further observation.

12. *Case 36.* Male, age twenty-two. No previous venereal infection.

Reported on July 14, 1921, with a copious urethral discharge, positive for gonococci. The first urine passed was cloudy, the second clear. There was considerable burning during the passing of urine, duration few hours; date of exposure uncertain. Second visit on July 15, 1921; no urethral discharge. First urine clear, with a few light and heavy shreds; second clear. On July 17 recurrence of discharge, positive for gonococci, stopped on July 20. During treatment for a prostatitis patient developed epididymitis on the sixtieth day.

13. *Case 54.* Male, age twenty-one. Gonorrhea four years ago, cured.

Reported on May 30, 1921, with a slight urethral discharge, positive for gonococci. First urine slightly hazy, with light and heavy shreds, second clear. Was exposed to infection several days previous; seven days duration. June 3, 1921, second visit, no discharge, patient says no discharge since the first treatment, first and second urines clear except for a few mucous shreds. Did not report for further observation.

15. *Case 107.* Male, age twenty-four. First infection in 1917, one recurrence since that time.

Reported on October 22, 1919, with a chronic urethritis, prostatitis and seminal vesiculitis; no gonococci were found in the smears. There was scanty urethral discharge first urine hazy, second slightly hazy. Patient reported off and on for treatment; receiving massage, irrigation, etc. The drugs used until May 16, 1921, were potassium permanganate and argyrol, the former for total irrigation the latter for instilling in the deep urethra. It was impossible to entirely clear the urines or stop the morning drop. Mercurophen was started on May 16, 1921. At that time there was a morning drop, with first urine slightly hazy, light and heavy shreds, second urine clear. The second visit on May 27, 1921, showed no discharge; first urine clear few light and heavy shreds, second clear. There has been no recurrence of the drop or hazy urines. The prostate and vesicles were negative on June 1, 1921.

CONCLUSIONS

1. Mercurophen has yielded uniformly good results in the treatment of gonococcal urethritis and particularly in acute infections.

2. All cases with the exception of three showed a considerable decrease in the number of infected cells per field after the first and second treatments.

3. The solutions of mercurophen employed in this study were 1:4000 to 1:10,000; these produced slight or no irritation of the urethra.

4. All treatments with mercurophen should be preceded by thoroughly cleansing the parts to be treated with a warm 1:8000 solution of potassium permanganate. Further details of the method of treatment are given in the text.

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THE METASTATIC COMPLICATIONS OF GONORRHEA AND THEIR TREATMENT

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The scanty attention given in literature to the metastatic complications of gonorrhea, the controversial nature of their treatment and the anxiety and uncertainty with which results may be looked for, are the reasons for this contribution. While the conditions we are about to discuss are fortunately rare, the general practitioner frequently is called upon to deal with them. Turning to general literature for guidance, he concludes that his search has been futile and he is left once again to his own resources.

These metastatic conditions are due to the spread of the gonococcus in the blood stream and therefore may be ascribed to generalized gonococcal infection. Whether the important factor is the gonococcus itself or a gonotoxin is a point as yet undecided.

The following conditions will be discussed: (1) Arthritis, (2) tenosynovitis, (3) myositis, (4) periositis and exostosis, (5) conjunctivitis and iritis, (6) hyperkeratosis, (7) implication of the heart and blood vessels, (8) pleuritis, peritonitis, mastitis and meningitis.

1. *Arthritis.* Gonococcal arthropathies always constitute a serious condition. As a rule they can be prevented by rigidly eliminating exercise during the acute stages of the urethritis. Arthritis occurs as a complication in 0.5 to 1 per cent of all cases of gonorrhea. Its incidence, therefore, as a sequel to prostatitis, vesiculitis and epididymitis, is fairly common. Predisposing causes are neglect of early treatment of the urethral infection, neglected complications such as prostatitis, too vigorous exercise during the acute disease, recurrent attacks of gonorrhea or

failure to cure an initial attack thoroughly. The occurrence of arthritis as a complication of gonococcal conjunctivitis in infants, and of vulvo-vaginitis in young girls, also, must not be forgotten.

Two forms of arthritis are recognized, although many varieties and sub-divisions have been described. The one is arthritis with much effusion and the other, arthritis with little effusion.

There is no absolutely characteristic feature or group of symptoms of the joint affection which will differentiate a gonococcal joint from one caused by some other affection. There is, however, invariably a history of previous or existing urethritis, which on occasion may be difficult to elicit. The severity of the joint condition bears a direct relation to any exacerbation or remission of the urethritis. The disease is seldom acute but is prone to settle down to a chronic and relapsing course. As a rule one joint inflames after another but occasionally several joints may light up simultaneously. Polyarticular implication is the rule. The profuse sweating of acute rheumatism usually is absent but a mild fever persists throughout. General weakness, muscular wasting, anorexia and cachexia progress very rapidly unless early treatment is instituted.

In spite of a long and tedious course, permanent damage to the joint seldom results. Ankylosis is rare but contractures from fibrous tissue formation, with stiffness and adhesions are common enough where treatment has been injudicious. Permanent damage may result from a phlegmonous arthritis, due to irreparable damage to the ligaments (Konig). Since intramine and vaccines have been available, however, the outlook of the gonococcal joint has improved infinitely.

The concurrent existence of a urethro-prostatitis, together with implication of the seminal vesicles, is the rule. The frequent association of a hyperkeratosis and a metastatic conjunctivitis and iritis must be borne in mind. A hyperkeratosis is very liable to be missed unless the soles of the feet are examined as a routine.

2. *Tenosynovitis.* Tenosynovitis and bursitis may occur alone or in association with arthropathies. Their onset may be very sudden or very slow and insidious. They may occur at any

stage of the gonococcal disease, early or late. Their course is a relapsing one. When associated with an arthritis, the tendon sheaths around the affected joints are those most frequently involved. When no arthritis is present, extensor tendons seem more prone to involvement than flexor tendons. Lesions are met with most frequently in the extensors of the arm and leg. The tendo Achilles and ligamentum nuchae are characteristic sites of inflammation.

Bursitis is rare except when associated with arthritis. Then it is due to direct extension from the joint.

Inflammation of the fascia of the plantar arch is more common than is supposed. Edema of the sole of the foot is met with, accompanied with pain in the arch when standing.

In all these inflammations serous exudation is the rule, and the tendency to fibrous tissue formation always marked. This is a point of importance, for if neglected, may lead to endless trouble from adhesions and contractures.

3. *Myositis*. McDonagh calls attention to the true gonococcal myositis which may arise by direct extension from any affected joint. Such an infection, however, may pick out any muscle, and give rise to a localized inflammatory painful swelling. The sartorius, rectus abdominis and trapezius are selected frequently. The gonococcal myalgia and rapid muscular atrophy so characteristic of prolonged gonococcal toxemias are well known. The tale of myalgia would form very painful reading for many an infected soldier who was compelled to carry out "fatigue" duty while his gonorrhea was yet acute.

4. *Periostitis and exostosis*. Periosteal involvement is recognized as a definite clinical entity complicating gonococcal disease. It is rarely primary, being secondary to tenosynovitis or arthritis as a rule. Indeed, in severe arthropathies the periosteum always is liable to become affected.

Exostoses are well known. Most characteristic is a painful bony outgrowth appearing on the tubercle of the os calcis lying just in front of the attachment to the plantar fascia (Baer). Invariably it is bilateral, and complete removal always is successful as a line of treatment.

5. *Conjunctivitis and iritis.* These conditions are seen frequently during the course of gonococcal disease. They occur as precursors or concomitants of other metastatic complications, particularly arthritides and cutaneous lesions. A urethral or urogenital focus usually is present. Both conditions may be unilateral or bilateral and show a marked tendency to recur. The liability of adhesion formation is a real danger and local treatment should be directed towards its prevention.

6. *Hyperkeratosis.* Keratoderma blennorrhagica is a gonotoxic rash always accompanied by two symptoms which complete the characteristic syndrome. These are urethritis and arthritis. Quite frequently metastatic conjunctivitis or iritis may precede or accompany the condition.

By far the commonest site affected is the soles of the feet. Next in order of frequency are the toes, the dorsa of the feet, the legs, glans penis, hands and scalp.

Since the introduction of chemotherapeutic agents and vaccines, the outlook is invariably good.

7. *Implication of the heart and blood vessels.* The specific identity of endocarditis as a gonococcal disease was first established by Thayer. It is the most common gonococcal heart disease. The mitral valve is most liable to implication but lesions of the aortic valve also occur.

Pericarditis is not frequent, and seldom, if ever, occurs alone. It is associated always with other heart affections or inflammations of other serous membranes (Hofmann). Myocarditis is less frequent still. The symptoms are those of ordinary infective myocarditis, with a well-marked and rapidly-progressive dilatation.

Possibly if all hearts were examined during the ordinary course of gonococcal urethritis, transient cardiac lesions might be found frequently. This is certainly the case in gonococcal arthropathies, where a normal heart is observed very seldom. Jagic and Schiffner conclude that gonococcal cardiac affections, especially mild forms of myocarditis, occur more frequently than is supposed. They suggest that many of the unexplained myocardial lesions of later life are gonococcal in origin.

A gonococcal phlebitis is very rare. In severe cases of hyperacute gonorrhea the dorsal veins of the penis may be affected, giving rise to a cord-like ridge which is palpable along the whole of the dorsum. It may be tender, but as a rule causes no inconvenience. The patient is apt to be alarmed, chiefly on account of the edema of the prepuce which is associated with it. The internal saphenous, the common femoral and the superficial abdominal veins are placed in the order of the frequency of their involvement (Heller).

8. *Pleuritis, peritonitis, mastitis and meningitis.* These conditions are exceedingly rare complications of gonococcal disease. Cases have been recorded by Wildenskov, Oxley and Dundas, Goldstein, and others. The clinical pictures resemble those of similar conditions of other etiology. Gonorrheal infection of the respiratory and digestive tracts has been reported (Schlittler, Goldstein).

TREATMENT

The first essential in the treatment of the metastatic complications of gonorrhea is the eradication of the focus of infection. Such a focus will be found invariably in the genito-urinary tract. It is often difficult to locate but its presence there may be taken as a foregone conclusion. Its eradication, therefore, entails an overhaul of the entire genito-urinary tract and the prosecution of energetic local treatment measures.

Next in importance is the vigorous prosecution of chemotherapy and vaccines. Nothing is more striking than the consistent results obtained by intramine and trimine in the treatment of gonococcal metastatic complications. It has been stated that similar results may be obtained by injections of peptones, proteoses, non-specific sera, milk and other foreign proteins. This is not so. There is no serious rise of temperature and no acceleration of pulse rate subsequent to the injection of trimine or intramine, as is the case with foreign protein. Moreover the latter can only produce results when the thermic reactions produced are intense (Lees).

It has been objected that the action of intramine is irregular and uncertain and that its chief virtue lies in the fact that it appears to intensify the action of vaccines. It is conceivable that there is sufficient ground for this objection in the earlier stages of gonococcal disease. In the later chronic complications, however, this objection cannot be entertained seriously. There is no doubt that these chemotherapeutic agents possess an action wider in its range than merely that of intensifying the action of vaccines. This is clear when we consider the good effect obtained by the use of trimine and intramine alone.

Some authorities have given the opinion that we are less likely to arrive at the ideal treatment along non-specific lines than we are by endeavoring to perfect our methods of preparing and administering vaccines. Our knowledge of the rationale of either method, however, is so limited that it is much too early to form an opinion which would entail relegating one method or the other to the background. The present position, therefore, is such that, on account of the limited state of our knowledge, we are not justified in discarding any agent which has proved itself of any real therapeutic significance. For this reason we can hope for better results by combining chemotherapeutic agents with vaccines than by using either group alone.

The best method of using vaccines is still a subject of much controversy, and there can be little doubt that vaccine therapy is still in its infancy. Sézary believes that vaccines have no immunizing effect unless they produce a thermic reaction ranging from 100.4° to 102.2°F. The dose, therefore, must be increased steadily. Vaccines with a high endotoxin content produce a definite negative phase in large doses, therefore the interval between doses must be studied carefully. Vaccines which have been detoxicated produce no negative phase nor do they produce any thermic reaction. Again toxic vaccines given in small doses do not produce a febrile reaction or a negative phase. The value of these vaccines must depend, then, on their immunizing response, the method of their administration and the interval between the doses. I have found that detoxicated vaccines, if the strain of organism is correct, are of high therapeutic efficiency

when given in large and steadily increasing doses at four-day intervals. Vaccines with a high endotoxin content, on the other hand, should be administered in *small* daily doses. If the interval between the doses is prolonged, or the size of the dose in

TABLE 1
With detoxicated vaccines

DAYS OF TREATMENT	INTRAMUSCULAR INJECTION
First.....	3 cc. intramine
Second.....	5000 m. detoxicated GC
Fifth.....	3 cc. intramine
Sixth.....	6000 m. detoxicated GC
Ninth.....	3 cc. intramine
Tenth.....	8000 m. detoxicated GC
Thirteenth.....	3 cc. intramine
Fourteenth.....	10,000 m. detoxicated GC
Seventeenth.....	1.5 cc. trimine
Eighteenth.....	12,000 m. detoxicated GC
Twenty-first.....	1.5 cc. trimine
Twenty-second.....	12,000 m. detoxicated GC

TABLE 2
With stock polyvalent vaccines

DAYS OF TREATMENT	INTRAMUSCULAR INJECTION
First.....	3 cc. intramine
Second, third and fourth.....	50 m. GC
Fifth.....	3 cc. intramine
Sixth, seventh and eighth.....	50 m. GC
Ninth.....	3 cc. intramine
Tenth, eleventh and twelfth.....	50 m. GC
Thirteenth.....	3 cc. intramine
Fourteenth, fifteenth and sixteenth.....	50 m. GC
Seventeenth.....	1.5 cc. trimine
Eighteenth, nineteenth and twentieth.....	50 m. GC
Twenty-first.....	1.5 cc. trimine
Twenty-second, twenty-third and twenty-fourth	50 m. GC

creased, the immunizing response is infinitesimal in the first case and the toxic upset and long negative phase are serious hindrances in the second. The following tables set out schemes of treatment which have been found to yield consistently good results, (1) with detoxicated vaccines, and (2) with ordinary

stock vaccines. The vaccines employed contained gonococci and secondary organisms in the proportion of 50,000,000 gonococci to 150,000,000 secondary organisms. The vaccines were polyvalent. In the following tables the number of organisms stated refer only to the number of gonococci. The number of secondary organisms may be gauged accordingly.

Should symptoms still supervene, a rest of two or three weeks should be given before repeating the course. Attention to the uro-genital focus, however, should not be interrupted.

TABLE 3
With detoxicated vaccines

DAYS OF TREATMENT	INTRAMUSCULAR INJECTION
First.....	1.5 cc. trimine
Second.....	10,000 m. detoxicated GC
Fifth.....	1.5 cc. trimine
Sixth.....	12,000 m. detoxicated GC
Ninth.....	3 cc. intramine
Tenth.....	15,000 m. detoxicated GC
Thirteenth.....	1.5 cc. trimine
Fourteenth.....	18,000 m. detoxicated GC
Seventeenth.....	3 cc. intramine
Eighteenth.....	20,000 m. detoxicated GC
Twenty-first.....	3 cc. intramine
Twenty-second.....	20,000 m. detoxicated GC
Twenty-fifth.....	3 cc. intramine

In chronic cases of long duration, and in neglected or imperfectly treated cases the courses detailed in tables 3 and 4 may be followed:

These courses may be preceded by the intravenous administration of 100 cc. colloidal iodine. The vaccines may be given by the intravenous route with advantage.

Recently I have replaced the vaccine in table 4 with the daily administration of the gonococcal vaccine of Bruschettini in 2 cc. doses. The results obtained have been such as to warrant further trial and investigation.

In the treatment of arthropathies, other measures are merely accessories, and if the treatment detailed above is followed out,

are seldom required. Vasotomy, vesiculotomy, and vesiculectomy have been practised with a view to eliminating the infecting focus. Since the advent of intramine, however, such radical procedures are called for no longer. Other measures include expectant treatment, Bier's hyperemia and non-specific immunization.

Expectant treatment. The patient is put to bed and his diet and bowels are regulated carefully. The limb is immobilized, protected from the weight of bed clothes, cold and exposure and anointed with various ointments and lotions. It is seldom

TABLE 4
With stock polyvalent vaccines

DAYS OF TREATMENT	INTRAMUSCULAR INJECTION
First.....	1.5 cc. trimine
Second, third and fourth.....	50 m. GC
Fifth.....	1.5 cc. trimine
Sixth, seventh and eighth.....	50 m. GC
Ninth.....	3 cc. intramine
Tenth, eleventh and twelfth.....	50 m. GC
Thirteenth.....	1.5 cc. trimine
Fourteenth, fifteenth and sixteenth.....	50 m. GC
Seventeenth.....	3 cc. intramine
Eighteenth, nineteenth, and twentieth.....	50 m. GC
Twenty-first.....	3 cc. intramine
Twenty-second, twenty-third and twenty-fourth	50 m. GC
Twenty-fifth.....	3 cc. intramine

wise to put the limb up in a splint. The knee, for example, is kept slightly flexed, resting on pillows on its outer aspect. The ankle is rested on a pillow, and supported on either side by sand-bags. A cradle to take the weight of bed-clothes off the limb is essential and will add greatly to the patient's comfort. Of the various cooling lotions employed, possibly the best is a saturated solution of magnesium sulphate and equal parts of alcohol and lead water. Heat in the form of fomentations is often useful, and radiant heat also has its uses. For the latter, one old-type carbon lamp or five or six new filament lamps hung inside a cradle over the limb for half an hour at a time may be used.

Sodium salicylate and potassium iodide given internally may reduce the activity of the fibrous tissue formation. McDonagh suggests colloidal iodine internally in 3iii doses thrice daily. This measure undoubtedly will increase the action of intramine and therefore may be adopted with advantage.

Therapy by means of antigonococcic sera has been reported on by Rogers and Torrey, Langeron and Bocca, Danilewitch, and others. It is of little service, however, since the appearance of intramine.

As soon as the acute condition has subsided and the joint can be moved without pain, massage and active and passive movements should be started. These procedures form a very important part of the later treatment.

Surgical treatment. Aspiration of a joint is called for sometimes and often will give very great relief. The knee joint is practically the only joint which ever requires tapping. One or two aspirations may be necessary before the condition resolves.

Murphy recommended the injection of 5 to 20 cc. of 2 per cent liquid formaldehyde in glycerine after aspiration. He put the limb up in extension in order to keep the articulating surfaces apart. The results were good but the procedure caused very considerable pain.

Arthrotomy seldom is called for. Klose finds that it offers the best hopes of good functional results in the smaller joints. Intramine, however, has modified very considerably the indications which he laid down for its employment.

Bier's Hyperemia. This useful accessory measure is applicable in every case where a rubber bandage can be applied proximal to the affected joint.

Non-specific immunization. Immunity results from the activities or products of the living tissue cells. The numerous factors involved are all variables. The resistance to infection by a particular organism can be raised in most instances by injections of vaccines or of foreign proteins. It is now recognized that there are two varieties of artificial immunity—specific and non-specific.

Large graded doses of antityphoid vaccine have been given both intravenously and subcutaneously in the treatment of arthropathies, with varying results. Milk injections have been found of value also (Trossarello). It was noted during the influenza pandemic of 1918-1919 that cases of arthritis suffering from influenza improved very considerably during the attack. (Fraser and Duncan). High temperature seems to be a very important factor in securing an immunizing response. Much failure with foreign-protein-therapy seems to be due to failure to graduate the dose, and to the employment of too small doses. A series of successfully treated cases has been reported by A. G. B. Duncan and the writer.

There is little to add with reference to the purely local treatment of the remaining conditions under review. If the urogenital focus is dealt with, and vaccines and chemotherapy pushed vigorously in every case, local treatment is purely symptomatic. The treatment of such complications as endocarditis, pleurisy, peritonitis and meningitis is the same as that required for similar conditions of other etiology. In every case, however, the rules laid down already should be followed. If this is done, the duration and severity of the disease will be reduced considerably and the outlook of these often distressing cases will be very much brighter.

SURGERY OF THE SCROTUM AND ITS CONTENTS UNDER REGIONAL ANESTHESIA

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In the selection of an anesthetic the considerations should be first, the safety of the patient, both during the operation and during the harmful after effects (7); second, the creation of the most favorable operative condition, keeping in mind the personal element of the surgeon and his individual technic in any particular operation, and third, the patient's preference and comfort. If the safety of the patient is to be compromised, the speed or difficulty of induction of anesthesia, the cost of the anesthetic, the need of more assistants and the question of quiet in the operating room should not influence the decision. It is admitted that none of the present day methods of anesthesia is absolutely safe and that no one method is indicated in all cases. In fact, much harm may result from the thoughtless use of the same type of anesthesia for all cases. The choice should be made only after a careful analysis of the conditions. The advantages of the several anesthetics should be considered with their effects on the body tissues in health and disease and a careful study of the condition of the important tissues and viscera should be made at the time of administration. It is largely owing to such a careful analysis of conditions, always with the appropriate preoperative preparation of the patient, that the danger from anesthesia today is exceedingly slight in the hands of the experienced and careful surgeon and anesthetist.

Until recent years a general anesthetic, usually ether, has been administered in the absence of contraindications and local anesthesia has been relegated to the field of minor surgery. The superficial location of the site of operation and the extent

and duration of the operative procedure have been the factors influencing the choice. With constantly increasing experience and improvements in technic, however, the field of local anesthesia has been enlarged to include many major operations and its popularity promises to increase. Many surgeons employ local anesthesia in all cases in which it is possible, with its aid, to operate painlessly and a few surgeons have even gone so far as radically to modify their operative technic to enable them to use local anesthesia in operations in the more difficult regions of the body, notably in the upper abdominal viscera (4).

After the surgeon has elected to use local anesthesia, it is necessary to decide by what method of technic the anesthesia is to be induced. The term local anesthesia was originally applied to the saturation, under pressure, of a tissue with an anesthetic agent, the operative procedure being carried out in the edematized area. Recent improvement in methods has evolved a technic to which the terms regional and conduction anesthesia have been applied; by this technic the nerves are anesthetized proximally and outside of the operative field. Harris and others include under the term local anesthesia, all forms of anesthesia, however induced, which effect a more or less limited area of the body in a conscious person. Thus the term has come to have a double meaning; it applies first, to all methods of anesthesia other than general narcosis, and second to terminal infiltration of tissues as first practised by Reclus, Schleich and Halsted. The application of the term local anesthesia to the latter procedure has lately been partially supplanted by the terms infiltration anesthesia, terminal infiltration and peripheral infiltration.

Accepting the term local anesthesia in its broadest sense there are today three distinct methods of induction, exclusive of spinal and intravascular methods: first, peripheral infiltration; second, field block, and third, nerve block (fig. 1). Field block (10) indicates the production of an area of anesthesia by a wall of anesthetic fluid projected by fanwise injections in the same plane. A larger area of distal anesthesia thus produced includes the operative field and is not invaded by anesthetic fluid. In

this procedure no attempt is made to anesthetize by one injection any particular nerve trunk of considerable size, as it is obvious that all nerve filaments passing through the wall of fluid will undergo physiologic block. Hackenbruch's (5) "circular analgesia," in which a smaller operative area is encased in a circular wall of anesthetic fluid, is a variety of field block. Field block then, occupies an intermediate position between infiltration anesthesia and nerve block.

In nerve block perineural injection of the larger nerve trunks is attempted. Use is made of the topographic anatomy of the

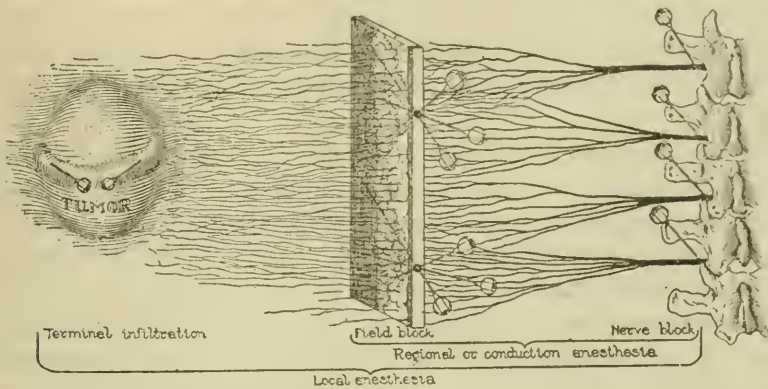


FIG. 1. THREE METHODS OF LOCAL ANESTHESIA WITH EXPLANATION OF TERMINOLOGY

The operative field is represented by the superficial tumor to the left, the site of incision having been anesthetized by direct infiltration.

nerves, especially their location with respect to the bony prominences of the body; for example, in paravertebral nerve block (9) the spinal nerves are blocked at their exits from the intervertebral foramina. As a wall of anesthesia is not necessary, fanwise injections are not made. The needle is usually passed, disconnected from the syringe and the injection is made while the needle is stationary and in a position believed to be correct for the particular nerve.

In planning the induction of local anesthesia the surgeon must have an accurate conception of the topographic anatomy of the

operative field and a concise idea of his operative procedure. He should then consider what is to be gained by terminal infiltration, field block or nerve block. If field block is to be employed, it must be decided whether the wall of anesthesia shall be circular, thus encasing the operative field, or the injections made in a straight line, in an angle, in a semicircle, or on one or two sides. If nerve block is to be used, the nerves involved must be determined and the most readily accessible points along their course be selected.

In surgery of the scrotal contents, if the inguinal incision extending downward only to the abdomino-scrotal juncture is used, the testicle being delivered from the scrotum upward through the high incision, the operative field includes the terminal portions of several nerves coming from both the lumbar and sacral plexuses.

Rather extensive paravertebral and parasacral nerve block would be required for this operative area, and the procedure itself would be painful and tiresome to the patient. Nerve block is technically more difficult to perform than field block or peripheral infiltration and a longer period of waiting is required for the appearance of anesthesia. Moreover, in many cases bilateral nerve block would be required even though the operation include only one-half of the scrotum. In our enthusiasm for newer methods we should be careful not to devise a method of anesthesia if its induction is to be accompanied by considerable pain and if the technic is to be more time consuming and more difficult than the operation itself.

An operative field near the middle line of the body, in which the terminal fibers of several nerve trunks are distributed and in which the cavities of the body are not involved, is usually well suited to field block. The technic is simple, safe and relatively painless and the anesthesia more certain. The many articles written in the last fifteen years concerning operations performed under local anesthesia have in the main been of a general nature. In some of the papers a description is given of the first few cases in which the author has performed operations under local anesthesia and includes an expression of his

satisfaction at having successfully employed something that is new. Other articles describe certain of the less common major operations usually not performed under local anesthesia illustrating the possibilities of the method but recounting accidental successes rather than the reverse. Such articles present the advantages of local anesthesia but articles by surgeons who have carefully studied the details of technic and have accurately described and illustrated these methods are largely responsible for the advance of the field of local anesthesia to its present position (8).

TECHNIC

The special metal and glass syringe and needles manufactured by Gentile and Company of Paris (11) are used in the induction of regional anesthesia at the Mayo Clinic. The various syringes used for hypodermatization lack the smooth running qualities and durability of the Gentile syringe and the needles are as a rule coarse, nonflexible and short. The Gentile needles, on the other hand, are of different lengths to suit the different anesthetic procedures, are semiflexible, are of an excellent quality of nickelplated steel and are provided at the base with an automatic locking device which is fastened to the bayonet attachment of the syringe by a half turn. The juncture of the nozzle of the syringe and the needle thus prevents leakage and the disconnection of the needle from the syringe, in making fanwise injections.

The anesthetic drug employed is procaine, which replaces with perfect satisfaction the German novocaine. It is prepared in 0.5 per cent strength in 0.45 per cent salt solution, and ten drops of 1:1000 epinephrin solution is added to each 100 cc. of procaine solution immediately before use. Twenty to twenty-five drops of epinephrin is the maximum used in any one case.

The cutaneous surfaces are prepared as for laparotomy and, with the smallest hypodermic needle, an intradermal wheal is raised at *a*, figure 2, about 1 inch internally and below the anterior superior iliac spine. The patient should previously be warned that he will feel a pin prick but that the pain will be slight,

lasting only an instant. A larger needle, 8 to 10 cm. long, is then introduced through this wheal and fanwise injections in the same plane are made below the abdominal aponeurosis into the broad muscles of the abdominal wall (fig. 3). In making these injections it is often difficult to recognize the different layers of tissue through which the needle passes. As soon as the larger needle is passed through the dermal wheal it en-

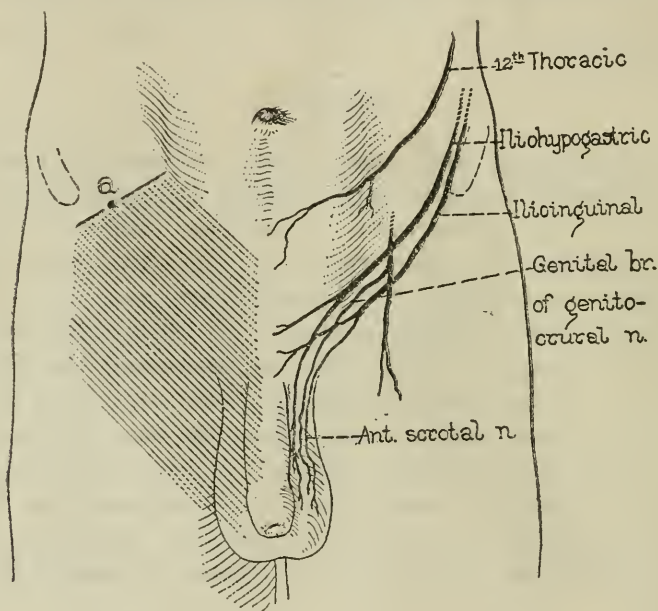


FIG. 2. LOW PARA-ILIAC FIELD BLOCK AND RESULTING ANESTHESIA, RIGHT SIDE

Nerve distribution to the inguinal region and scrotum shown on the left side

ters subcutaneous tissue which offers but little resistance to its course; increased resistance is encountered as the fascia is pierced. Very little resistance is offered to the passage of the needle through the muscle tissue of the external oblique, but increased resistance is felt as it pierces the fascial plane between the internal and external oblique muscles. In creating a wall of anesthesia it is important to inject continuously, both during advancement and withdrawal of the needle. The injections

extend from the ilium to the rectus abdominis muscle, the last medial deep injection being into the sheath of this muscle. Subcutaneous injections are then made in the same plane as the deep injections; these produce an area of anesthesia as repre-

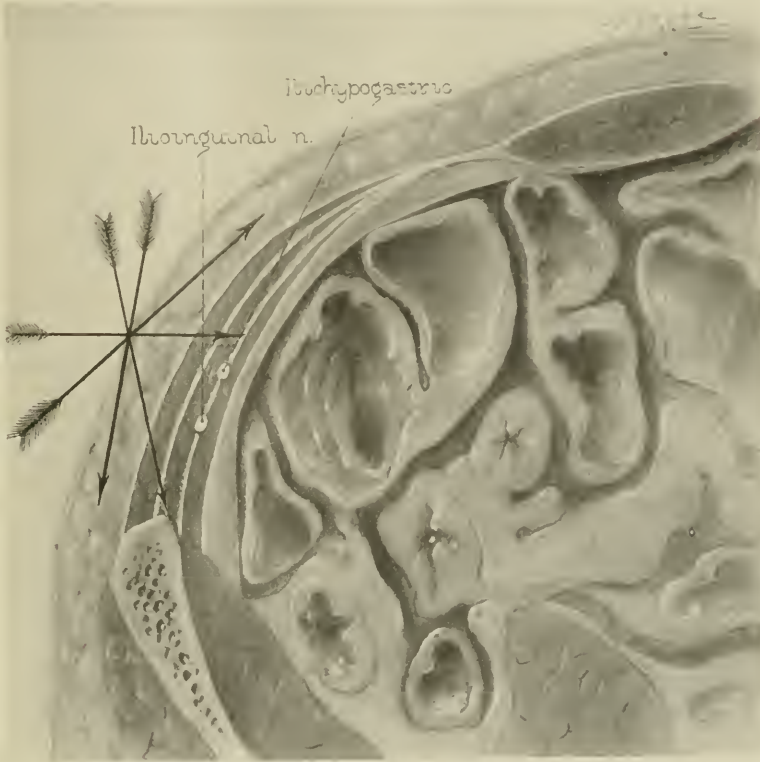


FIG. 3. CROSS SECTION THROUGH POINT *a*, FIGURE 2

Showing the method of injecting to obtain a wall of anesthesia extending from the ilium to the sheath of the rectus abdominis muscle.

sented in figure 2. Usually 40 to 50 cc. of solution are sufficient for these injections.

The pubic spine is next palpated and an intradermal wheal raised just medial to the cord (fig. 5, *b*). The cord structures are then grasped between the thumb and forefinger of the left hand (fig. 6) close to the external inguinal ring. Injections are

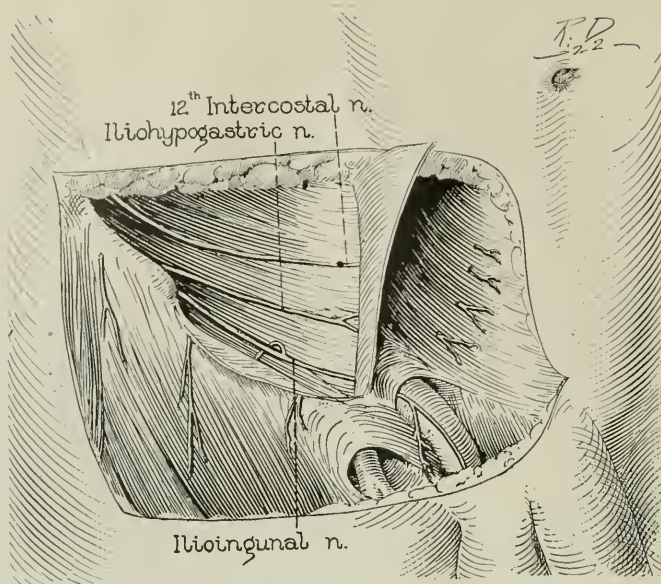


FIG. 4. ANATOMY OF THE RIGHT INGUINAL AND SCROTAL REGION (AFTER HARTEL)

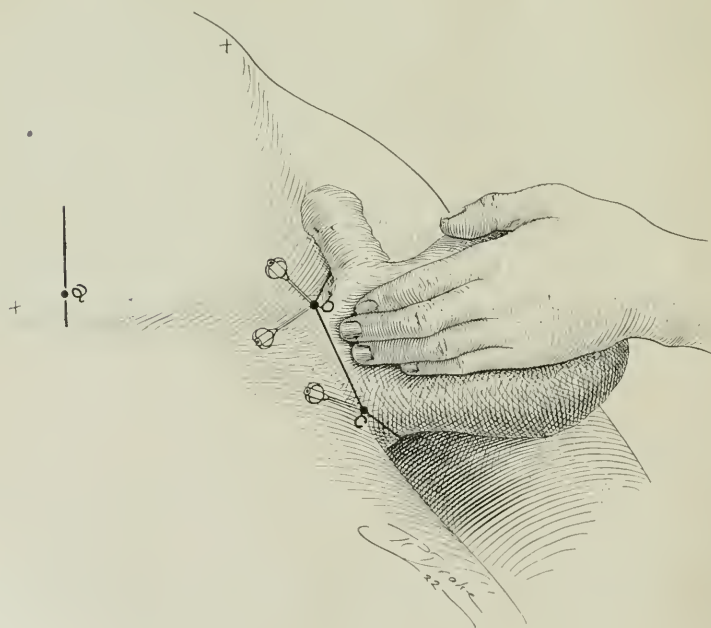


FIG. 5. CIRCUMFERENTIAL FIELD BLOCK OF THE BASE OF THE SCROTUM (MODIFIED FROM BRAUN)

a, Para-iliac wheal; *b*, pubic wheal; *c*, lateral scrotal wheal

made entirely around these structures and then directly into the coverings of the cord, after which the cord is well massaged. When the injections are made as the needle advances, the veins of the cord are rarely punctured and there is no danger of wounding the vas as it is readily pushed away by the injections. About 15 to 25 cc. of solution are used in this injection. Injections are next made through the pubic wheal along the margin of the pubis and above the base of the penis as far as the opposite

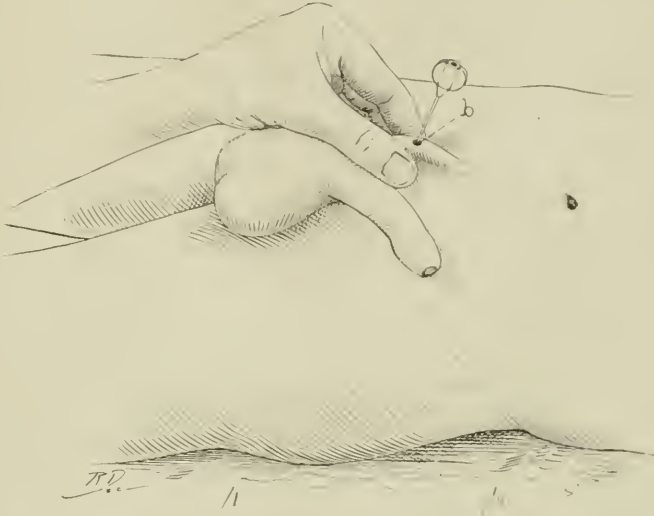


FIG. 6. BLOCK OF THE SPERMATIC CORD (AFTER RECLUS)

pubic spine. The overlying subcutaneous tissues are then infiltrated by fanwise injections to the skin.

The entire base of the scrotum is infiltrated at the abdominoscrotal juncture (3). Injections may be made downward from the pubic wheal, the left hand holding the scrotum aside and palpating the tissues and end of the needle as injections are made (fig. 5). The solutions should be carried well into the sulcus between the horizontal ramus of the pubis and the base of the penis. A lateral scrotal wheal, *c*, is next raised and injections made transversely across the posterior aspect of the scrotum according to Braun's technic (2) (fig. 7). About 50

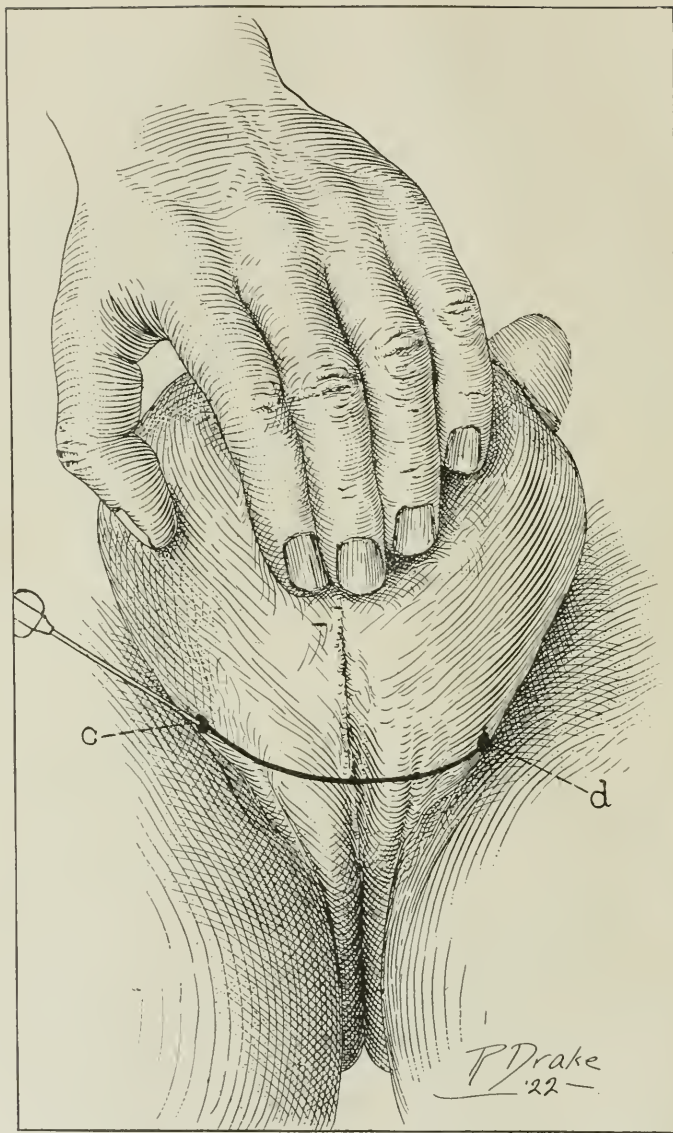


FIG. 7. CIRCUMINJECTION OF THE BASE OF THE SCROTUM POSTERIORLY
(AFTER BRAUN)

c and *d*, Lateral scrotal wheals

em. of solution is used in the circumferential injections and the base of the scrotum is well massaged in order to facilitate complete diffusion of the fluid.

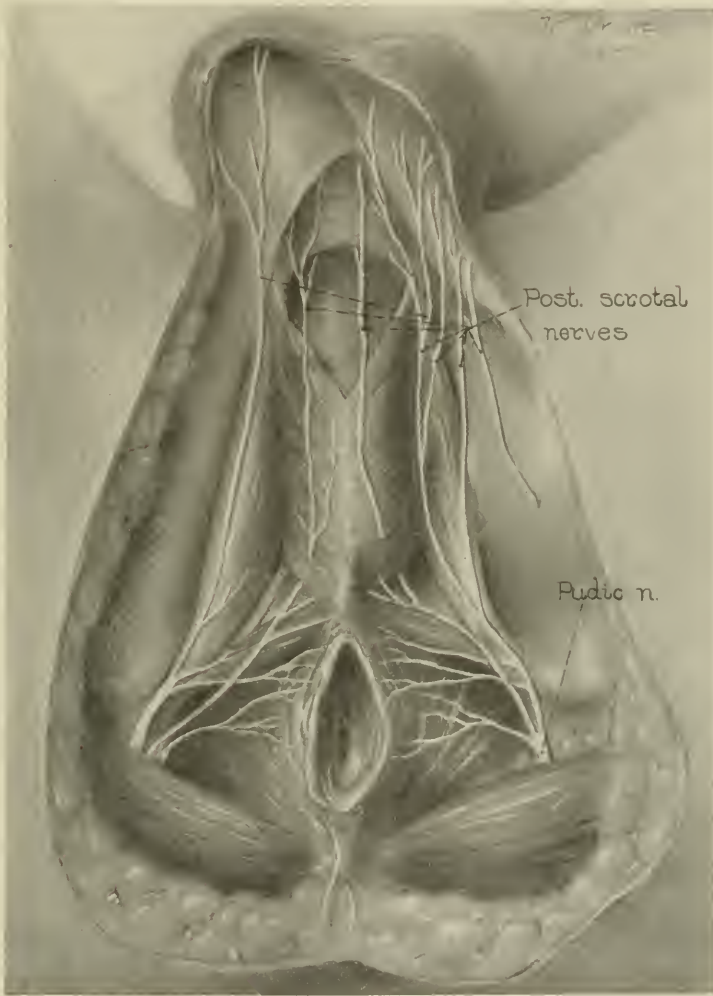


FIG. 8. INNERVATION OF THE POSTERIOR SCROTAL REGION (AFTER SPALTENHOLZ)

An entire circumferential field block of the base of the scrotum is made whether the operation is unilateral or bilateral (12). If bilateral procedures are employed, para-iliac field

block and injection of the cord structures are carried out on the opposite side in the manner described. A total of 125 to 150 cc. of solution is needed for unilateral operations and 200 to 250 cc. for bilateral operations. Twenty drops of epinephrin is generally used when both sides are to be operated on.

It is important to wait sufficiently long for anesthesia to become complete, usually about fifteen minutes after the last injection (13). Para-iliac field block allows a high incision and the retraction necessary to deliver the testicle upward. In bilateral scrotal operations the transverse pubic incision may be used, if preferred. It has been possible with this method painlessly to perform orchidectomy, epididymectomy and the various operations for varicocele and hydrocele. It is not always possible to lift up the cord, as in a large high lying hydrocele, so that this must occasionally be infiltrated after the inguinal incision has been made and the parts exposed(1).

The mental apprehension of a person about to undergo an operation may be allayed considerably by a preliminary hypodermic injection of morphin. The object of this is in no sense to combat pain or to smooth over an otherwise inadequate local technic but to produce a calm attitude. Worry and fear may make an operation a decidedly gruesome experience, even though the operative field is completely anesthetized. The size of the dose should vary with the individual case, enough being given to produce the desired result. The age, weight, temperament and general condition of the patient must be considered; $\frac{1}{6}$ grain is occasionally sufficient given one-half to one hour before the induction of anesthesia, $\frac{1}{4}$ grain is the average dose. In certain cases two doses of $\frac{1}{6}$ grain each have been given one-half hour apart, the latter dose being administered one-half hour to an hour before the induction of anesthesia.

Patients should not be allowed to come to the operating room faint from lack of food. On the morning of the operation a light breakfast may be taken and a normal diet may be resumed in the evening.

It adds much to the patient's mental ease during the operation if his attention is engaged by conversation with the regular anesthetist or an assistant. The assistant may also administer

small sips of water, sponge the patient's face and serve as the "psychic" or "vocal" anesthetist; his function may at times be as essential as the blocking of the operative field. In thus obtaining control of the patient's attention, it is possible to avoid any alarmed or turbulent mental condition which might interfere with a necessary surgical procedure.

CONCLUSIONS

1. Injections to induce local anesthesia should not be made haphazard and at random but the anesthesia should be planned beforehand with due consideration of the regional anatomy, nerve supply and the extent and technic of the operative work.

2. Low para-iliac field block, block of the cord and circumferential block of the base of the scrotum offer a simple and easy method of local anesthesia of the lower iliac and pubic regions and the scrotum and its contents.

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ANOMALOUS RELATIONSHIP OF THE RIGHT URETER TO THE INFERIOR VENA CAVA¹

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In the course of an experimental study of the ureter in which various types of laboratory animals were used, we have met the following anomaly on two occasions. The condition was first observed in a rabbit and subsequently in a cat. Both animals were fully grown. The anatomical pictures were alike in the two cases and we will describe the abnormality as it occurred in the cat (plate 1).

The right ureter, leaving the kidney normally, extended as usual obliquely downward and inward to the lateral border of the inferior vena cava. There, however, instead of maintaining its lateral position, it crossed the vein posteriorly and descended along its medial aspect. Continuing downward for a short distance between cava and aorta, it again crossed the vein, this time anteriorly, and resumed its normal course to the bladder. Throughout its extent the ureter was normal in size and peristaltic activity and the right kidney did not differ in appearance from the left. The inferior vena cava curved slightly outward at the level of the inward bend in the ureter.

This anomaly has long been known to anatomists and embryologists and it has been found repeatedly in the cat. We wish to emphasize the fact that it is also of clinical interest, for the condition has been observed in human subjects. The three recorded cases, however, have been made the basis of anatomical and embryological study and have not been called directly to the attention of clinicians. We will review them briefly.

¹ From the Laboratory of Surgical Research of the Harvard Medical School.

Hochstetter (1) in an extensive research upon the development of the venous system, came upon an anomaly identical with the one which we have described, occurring in an infant a few weeks old. Kolisko (2) found the same abnormality in a man of fifty-five years who had died of chronic plumbism. A double renal vein upon the right side was also present. The point at which the ureter crossed behind the inferior vena cava was about "two finger-breadths above the common iliacs." It is interesting that in this case there was a right hydronephrosis with well marked dilatation of the ureter above the level of its course beneath the cava. Gladstone's (3) case was that of a man aged eighty-four who was said to have died of "dementia, old age, and diarrhea." The right ureter was described as follows:

At the level of the disc between the fourth and fifth lumbar vertebrae, it formed a sharp bend inward and passed almost horizontally behind the inferior vena cava and in front of the sympathetic cord; it then appeared between the inferior vena cava and the aorta and passed downward to the pelvis crossing obliquely over the right common iliac artery, close to the bifurcation of the aorta. In the pelvis, it pursued the ordinary course of the ureter to the urinary bladder. The duct, above the segment which lay behind the inferior vena cava, was dilated to a diameter of about 12 mm. The pelvis of the ureter and the infundibula were also considerably dilated.

The inferior vena cava curved considerably to the right between the levels of the fifth and second lumbar vertebrae.

As Gladstone very properly suggested, this unusual course of the right ureter is of interest to the surgeon as well as to the embryologist. That such an anomaly may be met in the course of a surgical procedure is a matter of some importance. Furthermore, compression of the ureter by the inferior vena cava with resulting dilatation, is a rare but exceedingly interesting addition to the subject of hydronephrosis produced by anomalous blood-vessels. It will be noted that in both of the adult cases described above, hydronephrosis was present. In the infant there had not been sufficient time for its development. In animals, we have no record of dilatation of the ureter from this cause. Here again the time element may play a part and the

quadruped position, allowing the weight of the vena cava to be directed away from the ureter, may also be of influence.

Embryologically, the explanation for this condition lies in the development of the vein rather than of the ureter. In the normal embryo, the permanent kidneys, having formed in the pelvis, ascend cranialward. After passing the bifurcation of the aorta they encounter on either side the trunk of the posterior cardinal vein. They pass medial to these veins and then shift laterally behind them so that the ureter becomes wound around the vein precisely as in the present case. It then happens, in normal development, as shown by Hochstetter (4) in 1888, that the cardinal vein sends out anastomosing branches above and below, on the medial side of the ureter which thus becomes enclosed in a venous ring. By the atrophy and disappearance of the original lateral channel of the vein and the persistence of the medial half of the ring, the vein, as it were, has moved from one side of the ureter to the other. This is apparently a mechanical process whereby the blood stream avoids an obstruction and it takes place not only in human embryos but in those of rabbits, cats and mammals generally. The new-formed medial limb of the venous ring is a portion of the "supracardinal vein" of Huntington and McClure (6) and it becomes an integral part of the inferior vena cava of the adult. In the case of the anomaly which we are considering, the medial anastomosis did not occur upon the right side and, in the words of Dr. McClure (7) "it represents an instance in which the embryonic posterior cardinal vein of the right side has persisted as the portion of the inferior vena cava which lies caudal to the level of the renal veins."

To those who may be interested in further details, attention is called to the extensive work on the embryology of the inferior vena cava by Hochstetter (1), F. T. Lewis (5), and Huntington and McClure (6).

SUMMARY

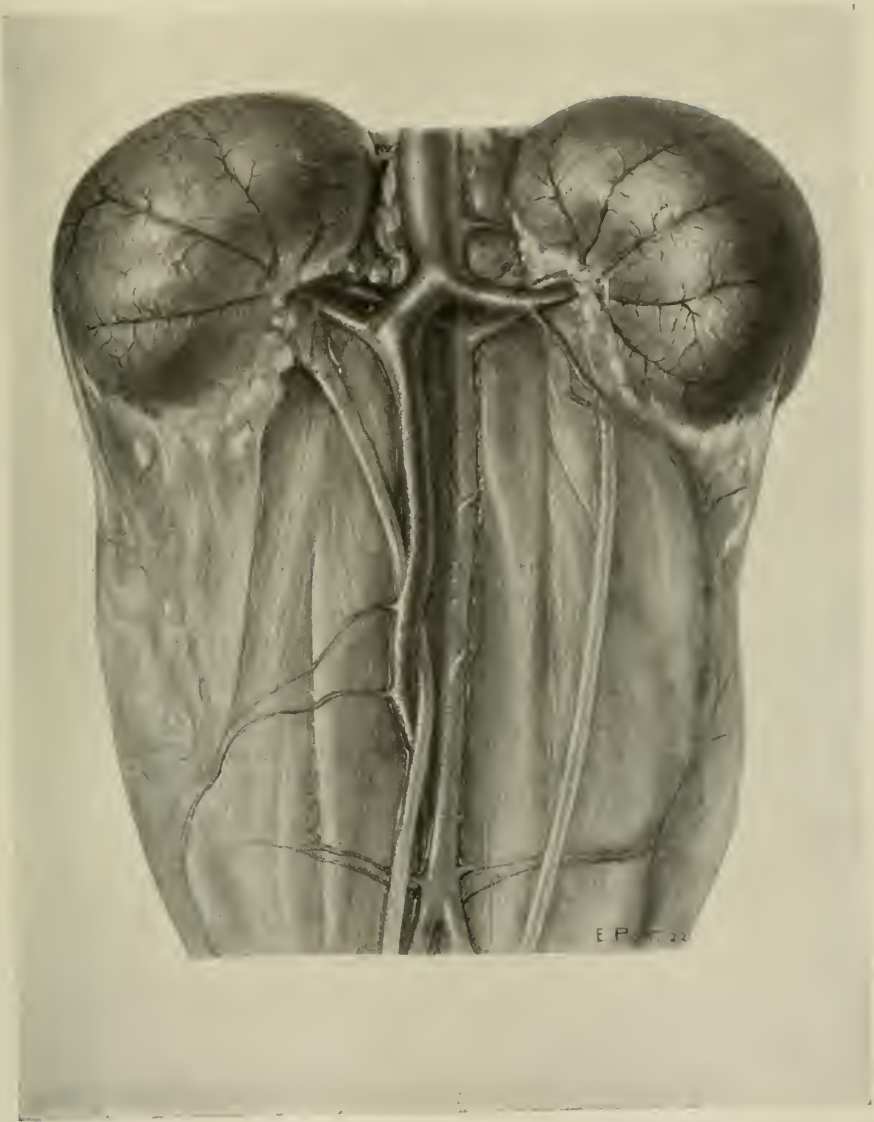
Because of an anomalous development of the venous system, the right ureter, in rare instances, crosses the inferior vena cava posteriorly. The condition is sometimes productive of hydronephrosis.

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PLATE 1

Drawing (actual size) of the upper portion of the urinary system of a cat, in which the right ureter was found to bear an anomalous relationship to the inferior vena cava. The peritoneum and fat have been dissected away to expose the structures more clearly.



SACRAL ANESTHESIA IN PERINEAL PROSTATECTOMY

A MODIFICATION OF YOUNG'S OPERATION WITH SUMMARY OF CASES

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The purpose of this paper is to discuss briefly: first, the value of sacral anesthesia in perineal prostatectomy; second, to describe and illustrate a modification of Young's perineal operation, and third, to give a brief summary of a series of cases operated upon at our clinic.

Our experience with sacral anesthesia has been eminently satisfactory. We have used it with one exception in 33 consecutive prostatectomies without an unpleasant result at the time of or following the operation. Its application is simple and easy, its dangers insignificant if given with due precaution. Its influence lasts from three to eight hours and does away with the gastric disturbances and pulmonary complications which frequently follow a general anesthetic. We believe it a good practice to use sacral anesthesia as a routine. It is certainly very advantageous in cases of arterio-sclerosis, cardiac and pulmonary complications and in cases of high blood pressure due to nephritis.

Deliberation and thoroughness are virtues in this work and under sacral anesthesia such is possible. Rapidity is important under a general anesthetic in order to prevent post-operative complications. Most people are afraid of a general anesthetic and this fear adds to the shock of the operation in such cases. Local anesthesia removes this fear.

Nerve blocking is a practice of long standing but its application for the removal of the prostate gland is of recent practice. In looking up the literature on the subject, we were surprised to find that Dr. Parker Sims was the only person reported as having done perineal prostatectomy under its influence. Many suprapubic prostatectomies, however, have been done under the combined influence of sacral anesthesia and infiltration of the abdominal muscles with cocain or novocain.

The sacral plexus is easily reached and blocked off through the triangular space formed by the sacral cornua at the sacrococcygeal articulation. A spinal puncture needle is inserted directly into the sacral canal until it is felt to pass through the ligamentous structure covering this triangular space. It is then directed upwards, parallel with the sacral canal for 3 or 4 mm., and 30 cc. of a 2 per cent solution of novocain is injected slowly in order that it may thoroughly infiltrate the tissues. Malformations of the spinal canal should be kept in mind and a moment's time elapse after the obturator is removed to see if the spinal fluid escapes; if so, the puncture should be made elsewhere. Twenty minutes should elapse after the solution is injected before the operation is begun.

The internal pudic nerve gives off filaments to the skin in the perineum, posterior half of the scrotum and to the penis. The anterior half of the scrotum is supplied by the genito-crural and ilio-inguinal nerves. The second, third and fourth sacral pairs of nerves constitute the hypogastric plexus which supplies the bladder, the rectum, the prostate and the pelvic peritoneum. From this distribution of nerves one can readily see how the entire field of operation is anesthetized by blocking off the sacral plexus. The traction on the pelvic peritoneum necessary to complete the enucleation occasionally causes pain and it is necessary to administer gas for a few minutes after the gland is exposed and separated from its capsule while delivering the gland. The extent of the anesthesia is largely dependent upon the accuracy with which the solution is injected. When used, the gas can be discontinued as soon as the gland is removed. The wound is closed without pain and the patient's suffering

greatly modified from three to eight hours after operation. There is practically no shock following the operation under its influence and certainly far less than that following a general anesthetic in our experience. We have seen no shock following this operation under sacral anesthesia.

Men change their views with regard to measures and methods as a result of scientific investigation and experience but there are certain fundamental principles which never change. The law of gravity is unalterable. This is undoubtedly true when applied to the drainage of wounds. No drainage is so effective as that from the most dependent point and this fact is taken advantage of by every surgeon. Even the gall bladder would thus be drained if possible.

A knowledge of this law was used by that great mechanical genius, scientific student and indomitable worker, Hugh Hampton Young in 1903, in designing an operation for the removal of the prostate gland, which drains not only the wound but also the urine without the use of mechanical devices. For nearly twenty years, notwithstanding the adverse criticisms of those who advocate other operations, this one has stood unchanged. Those of us who have followed his technique or slight modifications thereof, know that our percentage mortality has been less than that obtained by those who have done the suprapubic operation with its various modifications. We have had less complications during convalescence and to say the least we obtain equally as good permanent results. During the last twenty years statistics show that the percentage mortality following the suprapubic operation has been at least twice as great as that obtained following the perineal operation designed by Young. Some of the suprapubic advocates tell us that they lose more patients following the first step, in the two stage operation, than following the removal of the gland. These could not be reported as mortalities following prostatectomy since the gland had not been removed. We believe that the mortality following suprapubic drainage is greater than drainage by intermittent catheterization and the retention catheter.

This operation has been recognized for twenty years as the ideal perineal operation for the removal of the prostate gland but this does not signify that it cannot be improved upon. Young himself so recognizes this fact and has recently made some very excellent modifications of his original operation, a description of which you will find in the Journal of the American Medical Association, April 1, of this year. In it he advocates and illustrates very beautifully a method of removing the gland *en masse*. It is practically the operation we have been doing for the last two years and which was described by the reader of this paper in his chairman's address before the Urological Section of the Southern Medical Association at Hot Springs (1). The main differences in the two operations are: first, Young makes an inverted V-shaped or a unilateral incision through Desnonvilliers fascia and capsule of the gland on its inferior surface for the purpose of enucleation, whereas we peel it out of its capsule through the dilated prostatic urethra without disturbing this fascia or capsule. This part of his modification appeals to us however and we shall try it. Second, he makes an effort to preserve the mucous membrane covering the lateral lobes of the gland as well as the floor of the urethra. We destroy the urethral mucous membrane where all three lobes are enlarged and restore it by bringing down the intravesical portion of the capsule, covered with its mucous membrane and suturing it to the capsule below. The floor of the urethra is restored in the same way. Third, he still packs the capsule with plain gauze to control hemorrhage whereas we control it by packing gauze covered with perforated rubber tissue between the bladder drainage tube and the restored prostatic mucous membrane. This tissue-covered gauze does not adhere to the surrounding tissue, controls hemorrhage, is more easily removed and its removal is followed with less hemorrhage and causes less pain to the patient than when packed with plain gauze.

It is almost impossible to enucleate the gland, especially the large adenomatous one, without destroying or greatly injuring the prostatic mucous membrane and usually it had better be removed in such cases and restored in order to eliminate the

redundant folds of mucous membrane which later might obstruct urination. Of course every case is a law unto itself and the exact technique of its removal must be decided upon at the time of operation. In some cases of simple lateral lobe enlargement the original Young operation is preferable. Where all three lobes are enlarged, they peel out very easily *en masse* without injuring the ejaculatory ducts.

A study of the last 243 consecutive cases of perineal prostatectomy performed at our clinic reveals the following facts. The average age was sixty-six; the youngest patient was fifty and the oldest eighty-six. Thirty cases were operated on between the ages of fifty and sixty, 59 between sixty and sixty-five, 78 between sixty-five and seventy, 54 between seventy and seventy-five, 16 between seventy-five and eighty, 2 eighty, 3 eighty-one, and 1 eighty-six. Thirty-two or 13.16 per cent of these were malignant. Vesical calculi were present in 15 or 6.17 per cent. Of this series there is one case of incontinence following total excision of a carcinomatous prostate, and one case of perineal fistula in a case of carcinoma where the wound closed for three months and reopened. This patient is now at the point of death from metastases two years after operation. The wounds in two other recent cases are not yet closed; one of these was a malignant case in which we used radium. We feel that these will close shortly following a recent curettage. With these exceptions, our results in this series have been very gratifying. During the period of time covered by this series, nine cases were either refused operation or died shortly after first seen. Four cases were sent home because of serious cardiac or kidney disease—one of these was seventy-five years of age, another eighty years old, a third ninety-one, while the fourth was ninety-three. Of the remaining 5, one died of pneumonia during the period of preliminary preparation while the other four were so uremic when first seen that they died of this condition within three to eight days.

Of the four deaths occurring in the series, the first was the eighty-fifth case operated upon and was apparently due to

acute dilatation of the heart six hours after operation. The second was the one hundred and forty-fifth case and death was due to post-operative shock. The third death was the next case, the one hundred and forty-sixth, and was due to sepsis; the fourth or the one hundred and fifty-second case died of embolism on the eleventh day after operation. We have now operated upon ninety-two cases since we have had a death. This is the largest number of consecutive cases we have had in our work without a death. This is due to the fact that we have studied our cases more carefully each year from the laboratory standpoint as well as clinically. No patient is operated upon until his blood nitrogen and phthalein show the kidneys' function good. The blood pressure should be controlled at as near normal and stable a point as possible.

No patient should be operated upon following the withdrawal of the residual urine until he has completely recovered from the reaction which invariably follows this work. As a rule, the larger the amount of residual, the greater the reaction following its withdrawal. Intermittent catheterization is a better method than the suprapubic puncture or the retention catheter as the pressure can be reduced gradually in this way. Sudden relief of pressure in chronic retention is dangerous. The reaction is usually greater in cases having a large amount of residual without infection than in those with infection and the time of preparation for operation in such cases is considerably longer. The patient with infection has already developed a certain amount of resistance which is necessary before operation.

The blood pressure, phthalein output and blood nitrogen should always be ascertained at the outset, for upon these decision must be made as to the time for operation. It is a well-established fact that the blood pressure and phthalein output both drop following the withdrawal of the residual urine. The nitrogen retained in the blood indicates the degree of impairment of renal function, and together with the phthalein output, gives a guide as to the length of the preoperative management of the case.

CONCLUSIONS

1. The removal of the prostate gland under sacral anesthesia may be done as a routine and this form of anesthesia certainly should be taken advantage of in cases where a general anesthetic would be dangerous.

2. Young's operation (or its modifications) for the removal of the prostate offers the best drainage possible, is followed with fewer complications, requires a shorter stay in the hospital, gives greater comfort to the patient, causes less fatalities and gives as good permanent results as the suprapubic operation.

3. A summary of these 243 cases shows sufficiently good results to justify us in continuing this technique and recommending it to others.

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RENAL RETENTION DUE TO SEMINAL VESICULITIS

A REPORT OF THREE CASES¹

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In so far as we are able to determine by review of the literature, ureteral stenosis resulting in complete renal retention has been attributed to disease of the seminal vesicles in only one instance. Bilateral stenosis from this cause has never been reported. Valvular formation, or stricture of the ureter, has been considered by many writers, notably Bottomley (1), as being of congenital origin.

In the twenty-six cases collected by Morris (2), who inclines to the theory of congenital origin, there is one case reported of bilateral twist of the ureters on their own axes. Kelly (3), in 1902, stated that "strictures are caused by an inflammation in the ureteral walls produced by the commoner pyogenic cocci, by the gonococcus and by the tubercle bacillus. The commonest form of inflammation is that due to the tubercle bacillus and the rarest in my experience in women is due to the gonococcus." With the latter statement, Garceau (4), does not concur, while the studies of Buerger would bear out the findings of Kelly. Yet another view is that held by Hunner (5), who states: "I am firmly convinced that the majority of ureter strictures, excluding those of tuberculous origin, should be classified as simple chronic stricture, and that they have their origin in an infection of the ureter walls from some distant focus, such as diseased tonsils, sinuses, or teeth, or disease of the digestive tract."

Blocking of the ureters by bilateral impacted calculi, by new growths in the pelvis, by trauma produced by poorly managed or prolonged labor or by surgical procedures in the female pelvis, is not particularly uncommon.

¹ From the Urological Department of the Research Hospital. Read before the Chicago Urological Society, December 1, 1921.

In 1902 Morgan (6), under the title of "Valve Formation in the Lower Portion of the Ureter," quotes a case of unilateral uretero-hydronephrosis, in which after numerous operations he found the ureter pinched by firm bands of connective tissue from the left vesicle. It is quite evident from a review of Morgan's case that the obstruction in the ureter was due to a valve in the ureter itself and not to vesicular disease as it was found possible to pass a fairly large sound up the ureter following cystotomy.

In 1904 Young (7) reported the first case of total obstruction of the ureter caused from disease of the seminal vesicle. In this case it was impossible to pass a catheter up the right ureter. Nephrectomy with total ureterectomy was done. Exploration of the lower ureter disclosed the fact that a hard mass of fibrous tissue involving the right seminal vesicle completely surrounded the ureter at a point about one centimeter above the junction of the ureter with the bladder. Incision into the ureter demonstrated a tight stricture at this point making it impossible to pass even a filiform through it. Young says, "When we consider the close connection which exists between the seminal vesicles and the extremity of the ureter, it is surprising that inflammation of the former of these organs, does not more frequently affect the latter. It is necessary, however, to think that this condition is rare, since there does not exist in the literature any case which I have been able to find."

Belfield (8) in 1909 says, "Adhesions following infections of the vas and vesicles may therefore bind and obstruct the adjacent ureter." Herbst (9), in '1918 reports two cases of partial stenosis of the ureter, one of them accompanied by ureterocele, undoubtedly due to vesiculitis. He summarizes as follows: "(1) Stricture of the lower end of the ureter occurs more frequently than is commonly believed and not a few of them are of the inflammatory, acquired type. (2) Stricture of this part of the ureter may result from infection spreading from an adjacent seminal vesicle." In a personal communication of an unpublished case by Caulk he reports to the writer a case of partial stenosis in the right ureter with accompanying renal retention

due to a right seminal vesicle. Under local treatment to the vesicle for a short time this retention cleared up and a permanent cure was effected.

In view of the rarity of reported ureteral stenosis due to disease of the vesicles we have considered the following cases occurring over a period of a few months observation to be of more than ordinary interest.

Case 1. Hospital number, 32655

Patient, Mr. R. G., age twenty-five, entered the Research Hospital, walking, on August 23, 1921.

The family history was negative except for the fact that his father died at the age of thirty-seven from what was diagnosed as "Hodgkin's disease." The past history revealed the ordinary diseases of childhood, one attack of tonsillitis last winter and influenza in 1919. In July, 1920, there was a history of gonorrhea which was still present on entering the hospital. The patient stated that in September, 1920, his right kidney became very tender and painful, requiring opiates for one week to relieve the pain. At this time he had chills, high temperature, sweats, frequency of urination and pus in his urine. The diagnosis at that time by his family physician was that of pyelitis. He was confined to his bed for two weeks. Since the above illness the patient has been practically well up to two weeks previous to admission to the hospital.

The chief complaint on admission was a dull pain in the left loin accompanied by nausea. The pain, requiring opiates for its relief, was a dull aching pain located in the left loin and was not referred to the testes. The patient also complained of some pain in the right lower quadrant of the abdomen and the right renal region. There was no history of nocturia or of frequency of urination and no hematuria. Physical examination was negative except for a markedly enlarged left kidney and a slightly palpable right kidney. Both kidneys were tender to palpation. There was some enlargement of the inguinal lymph nodes. The tonsils were chronically hypertrophied. Rectal examination revealed two enormous sausage-sized vesicles, fairly extensive upward. Blood pressure was 140 mm. systolic and 80 mm. diastolic. The temperature was 98.2°F., pulse rate 80, and respirations 18 per minute.

Treatment. Rectal heat by thermophore.

August 24, second hospital day.

Symptoms. Patient spent a very comfortable day and night except for some pain in the left lumbar region. Temperature 98° to 99°F., pulse rate 84 and respirations 20 per minute.

Urine. Amount, 1½ ounces. Acid to litmus, specific gravity 1.012, trace albumen, many pus cells.

Blood. Red blood cells 5,000,000, white blood cells 12,000 with 70 per cent polynuclears. Urea nitrogen 16 mgm.

X-ray. Plates of the bladder were negative. Plates of the kidneys and ureters showed an enlarged left kidney.

Cystoscopy. No cystitis. Few pus flakes in the bladder. Both ureteral orifices normal. A number 4 catheter entered either ureter to about 1.5 cm. A filiform passed on the left side but not on the right.

August 25, third hospital day.

Symptoms. Patient restless and extremely nauseated. Vomited fluid small in amount and a light green color many times during the day and night. The patient did not void during the day or night but several times said he had a desire to void, though no urine could be obtained by catheter. Great pain and a feeling of tension in both loins was complained of. During the evening the patient became irrational. The temperature was 98° to 103°F., pulse rate 80 to 126, respiration 20 to 22 per minute.

Diagnosis. Bilateral vesiculitis with ureteritis and stricture and resultant hydronephrosis.

August 26, fourth hospital day. Day of operation.

Symptoms. Patient complains of pain in both lumbar regions. Condition before operation very poor. The patient was cyanotic and had the uremic odor to the breath. During the operation the patient became extremely shocked. After operation the general condition improved under hypodermoclysis and supportive treatment. He was irrational at times during the afternoon and evening. The temperature was 100.2° to 101.6°F., pulse 90 to 110, respirations 20 to 24 per minute. The blood pressure after operation was 100 mm. systolic, and 75 mm. diastolic. He spent a very restless and uncomfortable night.

Operation. Anesthetic, ether. Time, fifty-eight minutes. Left kidney exposed showed an enlarged kidney full of fluid under great tension. The pelvis was of the size of an orange. Drainage was effected through the cortex and the fluid spurted over the operator's shoulder. There was no hemorrhage from the cortex which was about 3 to 4 inches thick and very edematous. Hemorrhage from the kidney

pelvis was serve and uncontrollable. Rapid nephrectomy was done, clamps being left on the pedicle. The right kidney was exposed. It was enlarged and the pelvis was full of fluid but not under as much tension as was the left. Drainage was made through the cortex. The urine was clear. A small drainage tube was sutured through the cortex, the tube extending into the pelvis and brought out through the skin incision.

August 27, fifth hospital day.

Symptoms. Patient improved and spent a very comfortable day and night. The temperature was 99.8° to 101°F., the pulse rate 80 to 84, and the respiration 20 per minute.

Blood. Urea nitrogen 36 mgm.

Urine. Obtained through the nephrostomy tube. Acid to litmus, 1.009 specific gravity, heavy cloud of albumen, many pus and red blood cells. Rectal thermophore continued twice daily.

August 28, sixth hospital day.

Symptoms. The patient was only fairly comfortable during the day and night. He vomited once during the day. The clamps were removed from the pedicle of the left kidney and the patient appeared to be more comfortable. There was a good drainage from the nephrostomy wound. He voided about 250 cc. during the day. The temperature was 100° to 101°F, the pulse 80 to 82, and the respirations 20 per minute.

Blood. Urea nitrogen 34 mgm.

August 29, seventh hospital day.

Symptoms. Complaints of headache and nausea. Vomited several times during the day. General condition improved. He spent a fairly comfortable day and night. Free drainage from nephrostomy wound. Temperature 99.2° to 100°F., pulse 80, respirations 20 per minute. No drainage per urethram.

Urine. Collected from nephrostomy tube. Acid to litmus, specific gravity 1.010, good trace of albumen, many pus cells.

August 30, eighth hospital day.

Symptoms. Patient very much improved. Temperature 98.8° to 100°F.; pulse rate 80; respirations 20 per minute. Blood pressure 130 mm. systolic and 66 mm. diastolic.

August 31, ninth hospital day.

Symptoms. Sitting up in bed greatly improved. He spent a very comfortable day and night. Temperature respirations and pulse same as on August 30. Blood pressure 125 mm. systolic, 64 mm. diastolic.

September 1 to 9, tenth to eighteenth hospital days, inclusive.

Symptoms. Patient continued to improve each day. The temperature, respirations and pulse continued normal. The blood pressure on September 3 was 120 mm. systolic and 75 mm. diastolic.

Blood. The urea nitrogen had fallen from 34 mgm. to 28 mgm.

September 10, nineteenth hospital day. Day of operation.

Symptoms. Patients general condition very good before and after operation. Spent a very comfortable day and night with some pain in the rectum. Temperature 99° to 102°F.; respiration 22, pulse 90 to 100.

Operation. Anesthetic, ether. Time, forty-five minutes. Right vesicle showed up clearly with thin sacculated, flabby wall with some fibrosis at the tip only. Vesicle drained of a thick muco-purulent secretion. Small rubber tube left in place for drain. Left vesicle more indurated than right. Removed.

September 11 to 14, twentieth to twenty-third hospital days, inclusive.

Symptoms. Condition improved daily. Temperature down to 99.8°F.

Blood. Urea nitrogen 26 mgm.

Urine. Acid to litmus, specific gravity 1.007, trace albumen.

September 15 to 30, twenty-fourth to thirty-ninth hospital day.

Symptoms. Continued improvement daily.

September 21. Cystoscopy no. 4 ureter catheter followed by no. 6. Urine few pus cells.

September 24. Some pain in right kidney region. Nephrostomy tube removed.

September 27. Marked improvement. Practically no leakage through nephrostomy wound. Patient voiding urine showing few pus cells.

September 30. Condition good. Blood pressure 130 over 60.

October 1 to 23, fortieth to sixty-third hospital day. Uninterrupted improvement daily.

October 6. Blood urea nitrogen 6 mgm.

October 12. Urine acid to litmus, trace of albumen, specific gravity 1.010, few pus cells.

October 22. Cystoscopy: Right ureter allows passage of no. 6 catheter easily; silver nitrate 0.5 per cent irrigation.

October 23. Patient discharged from hospital.

Comment. In this case, primary attack upon the vesicles was out of the question. The patient was uremic; practically in coma, as a matter of fact. There was no certainty of immediate relief except by

nephrostomy. Ultimate removal of the large left hydronephrotic kidney was a certainty but its removal at the time of primary operation gave the operator a very anxious moment.

There would seem to be but little doubt that his attack of "pyelitis" in September, 1920, was a back-pressure from the right vesicle. The insidiousness of the advance of the left hydronephrosis is worthy of comment as is his apparent freedom from bladder symptoms.

Case 2. Hospital number 32858

Patient P. S. Age forty-four, married, 4 children living and well.

Family history. Not obtainable due to the fact that the patient left his place of birth, Austria, while still a child.

Past history. Unimportant save for operation for appendicitis fourteen years previous to admission. Venereal disease denied.

Present history. Three weeks previous to our seeing him, September 12, 1921, the patient was brought home with a high temperature following a rigor which he had while on the street. One week ago the patient began to have pains in right lower quadrant of the abdomen and in the right loin. This was accompanied by severe pain in the perineum and frequency of urination. At the time that we saw him at his home he was in extreme pain for which he had been given a $\frac{1}{2}$ grain of morphine by his family physician. This pain was mostly in the right kidney region and right lower quadrant of the abdomen. There was at this time a great deal of pain in the left lower quadrant of the abdomen with pronounced tenderness over the left costo-vertebral angle. According to the statements of the patient and of his family he had passed no urine for forty-eight hours. Percussion over the bladder area showed it to be apparently empty. He was sent immediately to the Research Hospital where catheterization obtained about 1 ounce of bloody urine.

Physical examination. A well nourished individual of about 155 pounds in weight; pupils small (due to morphine); teeth in bad condition; heart and lungs negative; reflexes hyperactive; tenderness over the brim of the pelvis on both sides; marked tenderness over both renal areas on deep pressure. Blood pressure 120 over 70 which rose on the following day to 140 over 80.

Radiograms of renal and ureteral regions negative for pathology.

Blood picture showed hemoglobin 90 per cent red blood cells 4,600,000; whites 13,900; polynuclears 71 per cent; blood urea-nitrogen 18 mgm. per 100 cc.

Rectal examination revealed two extremely large indurated vesicles extending into the prostatic area.

September 13, second hospital day.

No *urine* from time of entrance into hospital. Patient comfortable under morphine. Unable to sleep. Rectal thermophore used three times with one sitz bath.

Cystoscopy. There was generalized cystitis with slight puffiness of both ureter orifices with some bullous edema on the trigone. There was marked tumor pressure, evidently from without the bladder to both the right and left of the prostatic margin. Both ureters were easily catheterized using no. 4 catheters. There was a marked renal retention of about 6 ounces on either side. After thorough stripping of the vesicles of a large amount of pus the patient was put back to bed and the hot rectal thermophore used with resultant relief of the renal retention and pain.

Examination of the catheterized urine. Report by Dr. W. K. Trimble. Left kidney: A few hyaline casts; numerous caudate epithelial cells; a few small round epithelial cells; quite a few red blood cells; albumen present. Right kidney: Hyaline casts numerous; a few caudate cells.

September 14, third hospital day.

Patient free from pain. Voided 100 ounces. Phenolsulphonephthalein test: first hour, 10 per cent, second hour, 12 per cent.

Blood urea nitrogen 22 mgm. Blood pressure 150 over 95.

September 15, fourth hospital day.

Urethral discharge was noticed which was positive for gonococci. The patient then confessed of having had a gonorrhea for the past three months. The condition of the vesicles remained about as they were found in the first examination. Operation was advised but the patient refused, leaving the hospital on September 19 free from symptoms except those referable to the bladder neck.

Case 3. Hospital numbers 30554 and 32878

Patient Mr. O. Mc. Age 28. Entered Research Hospital February 1, 1921, with a diagnosis of acute appendicitis and was operated by one of the general surgeons on the staff the following morning under this diagnosis and an apparently pathological appendix removed. There was no pathological report.

Past history. This was very suggestive. About three weeks previous the patient was attacked with acute tonsillitis followed by a right sided quinsy. This attack of quinsy was followed about fifteen days later

with the appendiceal attack. The patient left the hospital eight days after operation apparently well.

Second entry into hospital, September 14, 1921.

There was a history of an absolute failure to recover full health from the date of his last illness and a loss of forty pounds during this time. Backache over both renal regions both day and night had been present with frequency of urination. Both renal regions were tender to palpation and both kidneys were palpable. The urine showed the presence of pus with a trace of albumen and amorphous phosphates. Blood: red blood cells 4,480,000; whites 16,600; polynuclears 68 per cent. On the basis of this finding diagnosis was made by his physician of bilateral pyelitis.

We were called in consultation for the purpose of determining the extent of the involvement.

Cystoscopy. There was a slight degree of cystitis with apparent pressure from the outside over the vesicular area of the bladder. Both ureters were easily catheterized, using no. 6 catheters, to the kidney pelves. Almost immediately upon passing the catheters 5 cm. into the ureter there was a very rapid flow of urine from each side which continued for some minutes, about $4\frac{1}{2}$ to 5 ounces being obtained from either side. The patient exclaimed at once that he was entirely free from his backache which had continued for so many months.

After removal of the cystoscope *digital examination* of the rectum was made revealing the presence of two enormously distended vesicles which were easily stripped and emptied out a large quantity of pus. Unfortunately no culture or microscopical examination was made but as there had been no history of any venereal disease or of any marital infection we feel that the vesicular involvement was a part and parcel of the infection which started in the tonsil.

Examination of the two kidney urines was negative for infection. The patient left the hospital with instructions to his family physician for continued stripping of the vesicles. A report received November, 1921, shows that this patient has remained free from symptoms and had regained fifteen pounds of his lost weight.

Comment. The above reported cases of hydronephrosis (or renal retention) were undoubtedly due to vesiculitis with pressure from the vesicles. Why, in the second case it was possible to readily pass ureter catheters from below and yet there be present complete retention above the juncture of the vesicle with the ureter is extremely puzzling. The third case, while not of the severity of the first and second cases, was beyond doubt a case of renal retention due to disease of the vesicles.

It is our hope that these cases will bring further reports bearing upon this phase of hydronephrosis.

Thanks are due Dr. D. C. Davis, interne at the Research Hospital for his compilation of the daily progress of these patients.

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PHYSIOLOGICAL AND PHARMACOLOGICAL STUDIES OF THE PROSTATE GLAND

V. EFFECT OF PROSTATECTOMY ON INTEGRATION OF MUSCULAR MOVEMENTS

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INTRODUCTION

In the preceding paper the authors (1) described the results of an investigation concerning the effect of prostatectomy on the behavior of rats in the circular maze. These experiments gave some indication concerning the relation of the prostate to what may be termed "mental efficiency." In the present investigation the authors have attempted to study the effects of prostatectomy on integrated movements. The method here employed is the so-called rope method, which has been used extensively by Ulrich (2) in the study of progression in rats and which is perhaps the most effective method of attacking the problem of muscular coordination.

METHOD

A medium sized cotton rope 1 cm. in diameter and 210 cm. in length is stretched tightly from one end of a room to the other at the height of about six feet from the floor. At each end of the rope is built a small wooden platform about 9 inches square, the surface of which is in the same plane with the rope. White rats are trained to cross the room on the rope from one platform to the other. The experiment is begun by placing a dish of food on one platform and placing a rat on the rope a few feet away and

allowing the animal to reach to the platform. On the following day the rat is placed a little further away from the food platform. On the third day the rat is placed on the rope at its middle, and on the fourth day, the experiment can generally be begun by placing the animal on the platform at the other end and allowing the rat to cross over the entire length of the rope. This method allows a study of progression along a narrow path with the limbs of the animal converged inward and not separated in a natural way when progressing on a flat surface. All of the rats used in these experiments were from forty-five to fifty days old at the beginning of the investigation. The animals were fed once in twenty-four hours after each trial on the rope. In the present investigation one trial a day was given to each rat, and it required on an average fifty days or fifty trials for each animal to master the problem completely and perfectly. At the beginning of training, progression along the rope is just barely possible with most of the rats. The animals make numerous slips, progression is arrhythmic and the body is crouched and poorly adjusted to progression along the rope. There is usually marked trembling of the entire body musculature with a swaying of the hind quarters. Frequently loss in equilibrium occurs and the rat becomes suspended by the forelegs, from which position it readjusts itself with difficulty and crawls forward to the food platform.

On continuing the training rhythmic progression along the rope appears from the fifteenth to the twentieth day of trial. This rhythmic progression is first noted in the front limbs while the hind limbs are lowered and are swaying. As the adjustment is bettered the hind quarters stand more firmly on the rope and are no longer crouching but are erect during the progression; so that after succeeding trials the animals run with both fore and hind legs erect, moving rhythmically, without slipping or loss of equilibrium. When this stage has been reached, it is noticed that the body musculature is much firmer and better developed. All of the muscles, the abdominal and especially those of the limbs, feel harder and appear to have increased in tone. These changes in the muscles must take place for efficient

adjustment of the body in order that progression may be rhythmic. The time for progression after the rope problem has been completely mastered ranged from four to six seconds, the average being about five seconds.

RESULTS

Two groups of experiments were performed. In the first group, when about fifty trials were given and when adjustment of the muscles for rhythmic progression along the rope was established the prostates were completely extirpated under ether anesthesia. The animals were given a rest of two weeks when

TABLE 1
Rats forty-five to fifty days old

BEFORE OPERATION, LAST TEN TRIALS				AFTER PROSTATECTOMY AND TWO WEEKS REST			
RAT NUMBER	Progression			RAT NUMBER	Progression last ten trials		
	Trials	Rhythmical	Arhythmical		Number of trials	Rhythmical	Arhythmical
1	50	4	7	1	16	7	3
2	50	5	5	2	16	5	5
3	50	5	5	3	16	7	3
4	50	1	9	4	16	6	4
5	50	6	4	5	16	5	5
6	50	3	7	6	16	7	3
7	50	4	7	7	16	7	3
8	50	5	6	8	16	7	3

retraining was begun. It was found that there was no impairment in the integration of muscular movements after this two weeks period of rest and 16 additional daily trials following it. Indeed, progression was in some instances even bettered. The results of these experiments are shown in table 1. These results are possibly conditioned by an increased development of the body musculature which completely offsets the effect of the operation and prostatectomy. The rats at the time of retraining were about one hundred days old and yet the progression was practically unaffected by the operation. The time for progression at this stage was the same as before the operation; namely, four

to six seconds. Control experiments were made by performing laparotomy under ether but leaving the prostate intact. The prostatectomized rats behaved the same as the control rats.

The second group of rats were not trained to adjust themselves completely for progression on the rope. Only sixteen trials were given each rat. They were then at once prostatectomized under ether and a two weeks rest period was allowed for recovery. After recovery from the operation, that is when the rats were about 66 days old, training was begun. During the early trials, that is until about the twentieth day the behavior on the rope seemed to be much the same as in the first group of rats. The

TABLE 2
Rats, 66 days old. Given 50 trials after prostatectomy

RAT NUMBER	NUMBER OF TRIALS	PROGRESSION		REMARKS
		Rhythmical	Arhythmical	
1	50		10	Hind quarters low, swayed
2	50		10	Hind quarters low, swayed
3	50		10	Hind quarters low, losses in equilibrium
4	50	3	7	Hind quarters low, swayed
5	50		10	Hind quarters low, swayed
6	50	1	9	Hind quarters low, swayed
7	50		10	Losses in equilibrium, swayed
8	50		10	Losses in equilibrium, swayed
9	50	1	9	Losses in equilibrium, swayed
10	50		10	Swayed

muscles were not adjusted and the progression was very poor, with swaying, loss of equilibrium, etc. After the trials were continued a marked difference was noted between this group of rats and the first one. Progression along the rope did not improve. There were marked variations in muscular coordination. Progression was much slower and more difficult, and at times trembling persisted with crouching of the body, even after a long series of trials. There were more frequent losses of equilibrium and the animals found it more difficult to adjust their bodies for a start on the rope. Sometimes the rats would not step on the rope at all, apparently being afraid to trust their muscles. The

hind quarters were greatly lowered to one side or the other and were *never erect* even after 50 or more trials. The animals were exhausted more quickly, and in some cases, progression was almost impossible, if the amount of food was reduced. The time of progression varied from five to eight seconds, so that the average time of crossing on the rope in this group of rats was over six seconds, whereas in the first group the average time was less than five seconds. These rats exhibited marked trembling of their bodies particularly of the hind quarters throughout the entire period of study and were unlike the first group of rats which showed this phenomenon only in the first days of training.

DISCUSSION

On comparing the two sets of experiments, it was at once noticeable that while in the first group of rats progression was not affected by prostatectomy, in the second group the muscular integration and progression were very much impaired. The authors thought it worth while to make a few feeding experiments in this connection. The rats of the second group were fed powdered dry prostate (Armour) with their bread and milk, and after a few days, a slight improvement in their progression was noted. There was a definite increase in speed, and the hind quarters were more erect and firmer. Still the animals did not behave the same as those in group 1. These rats were then fed on powdered whole suprarenal capsules plus dry prostate for twelve days and were found to improve even more than before with this suprarenal and prostate mixture. They no longer hesitated in starting on the rope and their trembling disappeared. The administration of the suprarenal and prostate powders was then stopped for seven days and the animals were again observed to return to their previous condition of weakness and lower tone. On repeating the feeding experiments an improvement was again noted. This effect of feeding the prostate and suprarenal was so striking that further experiments on the subject were started. The authors think it a little premature to draw any definite conclusions from the data on feeding so far in hand and deem it desirable to inquire into the subject a little further.

SUMMARY

1. The effect of prostatectomy on muscular coordination was studied by means of the "rope method."
2. When rats are first trained to adjust their muscles for rhythmic progression the effects of a subsequent prostatectomy are negligible.
3. When the prostate is extirpated before training of the muscles the effect is manifested by a distinct weakness in the muscles of progression especially in the hind quarters.

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THE VALUE OF BLOOD TRANSFUSION TO THE UROLOGIST¹

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Recent medical literature abounds with excellent articles on blood transfusion. Almost every essayist has reviewed its historical development and discussed the problems of technique involved. It is not the purpose of this paper to discuss the technical nor the biochemical phases of the subject. All these have been clearly described by others. The only excuse for this paper is to record some experiences that have been highly gratifying and considered of value.

Blood transfusion has developed to fill a needy therapeutic requirement in all the specialties in medicine but to the urologist it is proving to possess special merit. It is interesting to note, however, that articles on this subject mention with emphasis its value in the treatment of primary and secondary anemia, hemophilia, the cachexias, septic infections, acute hemorrhages, etc., without specifically mentioning those conditions in which we as urologists are concerned.

As a therapeutic measure, it offers to the urological surgeon all that it does to the general surgeon, and a great deal more. The very nature of our cases necessitates more painstaking and careful preoperative treatment than does the general run of surgical cases and the great strides in urological surgery which have been made in the last decade are the results more of the development in preoperative care than to operative technique. In prostatic surgery, for example, the reduction in mortality has been largely the result of preoperative preparation of our patients.

¹ Read before the Chicago Branch of the American Urological Society.

As a measure of value in this, blood transfusion stands out prominently. In addition to improving kidney function by establishing urinary drainage by whatever method desired, and instituting proper hygiene for the patient, the transfer of blood from a vigorous healthy donor to a weak, anemic, debilitated old man immediately vitalizes him and thus greatly shortens the preparatory time. For it has been well established that transfused blood not only increases the quality of blood by its own addition but that it acts as a stimulant to hemogenetic centers. It also increases the coagulability of the recipient's blood, which is always low in anemic conditions, thus reducing the liability to hemorrhages or excessive oozings. It is of especial value in preparing for operation patients suffering with kidney tumors, who have been weakened and made anemic by hemorrhages.

As an illustration, I recite the case of a patient suffering from hematuria of five days duration, with a history of previous intermittent attacks over a period of two years. Her blood pressure was 60 systolic. Her blood count showed hemoglobin 48, red cells 2,500,000 and white cells 9375. Her pulse was 140, and very feeble. The patient was very pale and in a state of shock. A transfusion of 500 cc. of blood was given. The blood pressure rose to 90, and the general condition improved. The hematuria ceased. During the night the pressure gradually dropped, reaching 68 in the morning. Another transfusion of 500 cc. of blood was given, and the pressure rose to 90, and stayed about 90 throughout the day. The following morning a nephrectomy was performed, removing a large hypernephroma. Not much blood was lost in the operation. Soon after the operation the blood pressure again dropped to 60, and a third transfusion was given of 500 cc. It came up to 88, and gradually from this point it rose, reaching as high as 106 on the tenth day. The patient left hospital on the twenty-seventh day, with the wound all healed, and made a comfortable journey to her home in Omaha, Nebraska. We felt that blood transfusion made this recovery possible, for without it the operation would never have been attempted.

It accomplishes the same results with all anemic and debilitated patients upon whom a major operation is necessary, particularly those reduced by recent hemorrhages from bladder tumors, etc.

In the post-operative treatment of shock, hemorrhages, oozings, and failure to rebound, we have experienced blood transfusion to be a source of great help and satisfaction. Cases of infection where the indications clearly demonstrated the patient's inability to master the invading organisms, it has certainly been pleasing to see the change from a progressive infection to a healing wound soon after a transfusion. In some cases it has been as striking as the dissolution of a diphtheritic membrane after an injection of antitoxin.

As a means of combating shock it stands out preëminently. Our experience with this condition is similar to that of Lowsley's. For years we have considered falling blood pressure an indication of impending shock and consequently have blood pressure readings made every five minutes during prolonged operations and at frequent intervals after the patient's return to his room. In earlier years a dropping pressure was met with a saline infusion. This was found of benefit in raising the pressure and combating shock but its effects were too frequently transient. For the past two years we have used gum glucose in all cases possessing a fair quality of blood. It is given simultaneously with the operation or after the return to the room, at the very onset of a definite drop in blood pressure. The results have been satisfactory. Our estimation of its use, like that of Lowsley, is, that while not 100 per cent efficient, it is certainly pleasing to see the more vigorous condition of the patient following its use. In anemic and debilitated cases, however, we have found, that a blood transfusion possesses superior merits, for it not only overcomes all indications of shock but adds to the cellular and hemoglobin content of the blood, which is more lasting benefit to the patient. Our experience justifies the conclusion that it shortens convalescence, fortifies the patient against infections and greatly reduces the anxiety of both patient and surgeon.

The reports of obstetricians of the successful use of blood transfusion in the treatment of puerperal sepsis suggested to me its

use in cases of acute fulminating infections of the urinary tract. In fact, it is in this field that we have had our most pleasing results. The most striking case was that of a man seventy years old, with an acute virulent mixed infection of a multiple diverticulated bladder. There was from five to six ounces of residual urine, thick with pus. He had chills and fever. The blood count showed hemoglobin 50, red cells 2,550,000 and white cells, 12,000. The patient was unsuitable for surgery, being a cardio-vascular case, very weak and debilitated, and showed no fight against his infection. After several weeks of careful treatment, including permanent catheter drainage and irrigations, without any signs of improvement, he was given three transfusions of 500 cc. each on alternate days. The results were very striking. His appetite returned, he became stronger, and while the infection was not completely eradicated, the virulence subsided and the patient was able to go home. In one case of prostatic abscess with perineal drainage, where, in spite of the usual supportive treatment, the patient kept slipping, an immediate improvement was apparent after one transfusion, which continued on to a cure. The immediate effect of the transfusion upon infections demonstrates that fresh healthy blood added to a toxic debilitated blood raises the bactericidal powers of the patient.

I have had experience with two cases of acute nephritis that have been most satisfactory. It is in these cases that I believe that blood transfusion will serve us the best. Both were acute virulent cases with almost complete anuria. The first was a boy aged seven, whose case developed two days after getting wet early in the spring. The history showed that his sister had scarlatina. He had manifested no signs of the illness, so was allowed to go to the country before she was quarantined. He evidently had a masked case of scarlet fever, which was the actual cause of his nephritis. I saw him in consultation on the fourth day of his illness. At this time he had general edema, albuminuric retinitis, vomiting, intense headaches, with uremic odor. The urine was very scanty and muddy and heavy with albumen, blood cells and pus. In spite of approved treatment, his condi-

tion grew worse. Two days later he developed a complete kidney block, with convulsions, as many as seven in one hour, with deep intervening coma. A phlebotomy, with removal of 500 cc. of blood and infusion of 1000 cc. of Ringer's solution was performed. This stopped the convulsions, relieved the kidney block and the coma. Patient was greatly revived. Ten hours later he developed hemorrhage from the nose and lost considerable blood. This hemorrhage was not controlled even by packing. A transfusion of 500 cc. of blood stopped the bleeding at once. There was an immediate improvement, and the child continued his convalescence uninterruptedly to a complete recovery and today is perfectly healthy with no evidence of renal trouble.

Experience with another case of acute nephritis with kidney block further demonstrated the value of phlebotomy, with the withdrawal of from 500 cc. to 1000 cc. of the thick toxic blood, which was surcharged with retained urinary products and replacing it with a greater quantity of Ringer's solution, and 500 cc. of healthy blood. It was followed by an immediate improvement, the patient regained consciousness and kidney function was resumed—four hours later six ounces of urine were passed. This improvement was only temporary, however, as the condition gradually lapsed. On the next morning, the patient was again in coma. The same regime was repeated three times in four days with an immediate improvement after each one but gradual lapse after the first two. The patient made gradual improvement after the last treatment and made a complete recovery. His urine test upon leaving showed no blood cells albumen or casts. There were a few pus cells and *B. coli*.

Otterbury recites the danger of producing acute suppression of urine following blood transfusion in cases of damaged kidneys, one his own, and one another's. One was given by sodium citrate method, and the other by the direct canula method. He reported the two cases to record the existing danger but he considers it exceedingly rare. We believe that the danger does not exist in kidney cases with anemia; when properly administered.

We are encouraged by these results and believe that by supplanting the thick toxin-laden blood of the acute nephritic with healthy pure blood from a vigorous donor, we possess a measure of great value when it is judiciously used for the treatment of virulent renal infections. We believe that phlebotomy with the withdrawal of from 500 cc. to 1000 cc. of blood and saline infusion in cases of acute nephritis with suppression is rational therapy. It is effective and efficient without being accompanied or followed by a blood transfusion but the transfusion eliminates the severe grade of anemia which would otherwise occur and which would produce exhausting effects and favor extensive degeneration of parenchymatous organs and greatly shortens convalescence.

We have used the standard sodium citrate method, and in our series of over 200 transfusions have had no serious reactions. We believe that by accurate typing, strict asepsis and avoiding chilling the blood, the slight reaction which sometimes occurs can be avoided. Our supply of donors has been ample, mostly from young healthy college students. A suitable number are typed and listed, making it easy to get a donor of correct type on short notice. They are typed according to the Moss agglutination test.

Specialists working along other lines are describing blood transfusion as a measure of value in the treatment of many conditions, such as illuminating gas poisoning, emesis of pregnancy, acute puerperal sepsis, septicemia, etc. It is referred to as a "life-saving power in emergency," "a means of revivifying a dying man," and by other extravagant phrases, such as "when in doubt, resort to transfusion," etc. As a result of the over-enthusiasm of the zealous worker, there is no doubt but what exaggerated statements will be made, which will result in a reaction of the pendulum of its popularity. We do not believe it is a measure to utilize on slight provocation but are convinced that, as a therapeutic and life-saving measure it possesses many possibilities, both known and unknown and that its value merits its more frequent use by urologists.

DISCUSSION

DR. BRANSFORD LEWIS, St. Louis, Missouri: I look upon this as a valuable contribution, not that the author has presented it as something new, but in the light of practical utility. I have availed myself of the assistance of blood transfusion in prostatic cases when the patient did not "come back" after operation; where shock had seriously devitalized and debilitated the patient and the various other methods did not seem to bring about the desired results.

One case I recall in particular was a man, seventy years of age, from whom I had removed his prostate suprapubically after considerable preparatory treatment. He did not improve. It was a case in which there was carcinomatous involvement and I took out a very large prostate. We used transfusion and he improved wonderfully. The operation was done three or four years ago. He has gained forty pounds in weight since then. I believe he would have died if we had not given him transfusion.

In recommending transfusion before operation, Dr. Martin has presented a new idea which we can utilize along with our other preparatory measures.

DR. HENRY L. SANFORD, Cleveland, Ohio: We have used blood transfusion in the preoperative preparation of our bladder and prostatic cases and find there is nothing that will take the place of human blood.

With regard to the use of glucose, Professor Cannon of the Harvard Medical School was a major in the medical corps in France and had a special shock team. He took a lot of this gum glucose solution and used it in many cases of shock. He had a tremendous opportunity to test it out thoroughly, thinking he would get excellent results but he was disappointed in it. We use direct blood in an unmodified way and never have any trouble from reactions.

I think Dr. Martin brought forth a valuable idea which we can all use to great advantage.

DR. VICTOR D. LESPINASSE, Chicago, Illinois: It has taken ten years for the profession to wake up in regard to blood transfusion. I read a paper with the same title at the Philadelphia meeting of the American Urological Society years ago which received no discussion. At that time transfusion was not as well developed technically as it is today. Then transfusion was a surgical operation of great technical magnitude, one which required considerable preliminary practice to perform. At the present time five minutes instruction will enable any intelligent surgeon to perform transfusion. The technical side of transfusion is important as regards the results. If you are going to use transfusion in your preliminary treatment of prostate and bladder cases, you need to be very careful about reactions, for every once in a while a severe reaction will help to send the patient down instead of up. When transfusion is used in cases of infection one should use an immune donor, if such is possible.

I have done blood transfusions for all sorts of conditions, in puerperal sepsis, in urinary sepsis, prostatic conditions of every sort, malignant endocarditis, and in all these instances there is an enormous field for it. In the treatment of cases of poisoning it is of little or no value, excepting in kidney cases (uremia). In acute nephritis from infection I prefer to give patients back their own blood. Remove it, wash the corpuscles and then reintroduce them. If you take out blood, be prepared with a donor, so that you will surely be able to put blood back. If you take out 1000 cc. of blood from a person, you must have blood to put back. Occasionally through some technical accident your removed blood will be lost, and then you will have the donor there to make up for the loss. The kidney lesions of eclamptic babies are the type of cases that impress me most from the standpoint of transfusion. Under these circumstances you have a small patient, you can open one side of the neck, to allow the toxic blood to run out, run blood in the other side of the neck and wash it through, so that, by taking out 1000 cc. of

blood from a donor, you wash that three or four times, and when you get through the babe has perfectly normal blood in his veins. The same technic can be used on adults with acute kidney suppression.

DR. F. M. DENSLOW, Kansas City, Missouri: What is the danger signal in giving transfusion? I understand we can control the respiratory depression by the use of morphin, but when should we stop transfusion if a patient is not getting along very well?

DR. MARTIN (closing): With reference to Dr. Denslow's question, I will state that we have never had any very serious reactions. In two cases we had hemolysis, due to a clerical error made in recording the type of the donor, consequently the bloods were incompatible. It has been our technic to give the first 50 or 75 cc. of blood very slowly, the reaction due to hemolysis always manifesting itself with the first 75 cc. of blood injected. The symptoms are interference with the respiratory function with a depressed feeling in the epigastrium and a tingling all over the body with a cyanotic condition. These are danger signals, the transfusion should be stopped at once and investigation made to establish the cause of the reaction.

I had one experience which demonstrated that a reaction can occur following the use of old saline solution. The patient manifested similar symptoms of reaction to those recited above. The saline solution used in connection with the blood transfused must always be made with freshly distilled water.

I wish to emphasize the value of the withdrawal of blood in cases of acute nephritis with blocked kidney. It is a rational therapeutic measure, because it relieves the kidney block, stops the convulsions and gives the patient a chance to get well. Blood transfusion either at the time or shortly following such a phlebotomy greatly facilitates the progress of these cases. I commend it as a valuable remedy.

UNDIAGNOSED RENAL HEMORRHAGE¹

IRVIN S. KOLL

Chicago

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In presenting this paper to you my attempt has been to discuss the subject of occult renal bleeding differently from those conclusions found among the legion of articles in medical literature.

The title as expressed "Undiagnosed renal hemorrhage" is to be translated into an appeal for help in the desire to bring forth, if possible, some standard method whereby kidneys need not be sacrificed as were the author's two cases herein reported.

A perusal of the literature on the subject of hemorrhage from the kidney leaves one in a state of mental confusion. Etiology, pathology, diagnosis and treatment are discussed voluminously with as many different conclusions. The etiology is vague and in most instances wholly theroretical; the pathology is meager, the diagnosis even with the adjunct of modern radiography and pyelography is inadequate and finally the treatment one of per-adventure. With opinions at such variance we must admit that as yet we are wandering in complete darkness.

Kretschmer (1) in 1907 gave an exhaustive résumé of the literature up to that year. From 1907 to the present time there have been found but few contributions which were not ready to dismiss the subject with the time honored cloak of ignorance "idiopathic and essential hematuria."

I exclude from consideration renal hemorrhage produced by calculi, infections, neoplasms, toxemias and those forms of nephritis with anatomical changes.

Israel (2) gives no credence whatever to either the angioneurosis of Klemperer or the hemophilic theory of Senator. He quotes

¹ Read before the Chicago Branch of the American Urological Society, January 26, 1922.

6 cases (3) up to 1901 with negative gross anatomical findings at operation determined by splitting the kidneys, which is wholly inconclusive.

Edward L. Young (4) under the caption "Renal hematuria as a symptom of a prenephritic condition of the kidneys," cites 33 cases of renal hemorrhage, 19 of which were operated, 3 having nephrectomy. Of these 3 cases, 1 showed angioma of a papilla, 1 nothing but congestion and the third was given the microscopic diagnosis of chronic infectious nephritis.

Although there are few authenticated cases from which to draw deductions, on the surface it seems illogical and unscientific to conclude that there is no real underlying cause for these renal hemorrhages in which there has been no demonstrable histologic lesion. The point immediately arises: Is it not possible even in the hands of an expert pathologist that some damaged areas may be overlooked?

To be entirely speculative two questions suggest themselves: Is the hemorrhage due to some disturbance of the nervous mechanism of the kidney; or, is the bleeding a "prenephritic condition"? This latter has an interesting appeal and gives sufficient impetus to lead to investigation.

What mostly concerns the writer, at this time is how can we formulate data in this type of case whereby the kidney need not be sacrificed and yet avoid the danger of temporizing with a possible neoplasm or insipient tuberculosis.

Exploration of the kidney by digital examination following delivery is inadequate as shown in my two cases. Splitting the kidney is now generally considered by most Urologists as distinctly unsurgical. What then?

The author's two cases follow.

Case 1. Female, age forty-five. Noticed blood in her urine ten days before consulting me at my clinic at the Post Graduate Hospital. She thought at first that she was approaching the menopause and that the hemorrhage was uterine. Two days prior to entrance to hospital she had a typical renal colic of about an hour's duration, following the cessation of pain a large clot was passed from the bladder. There was nothing of interest in the previous history. The physical examination

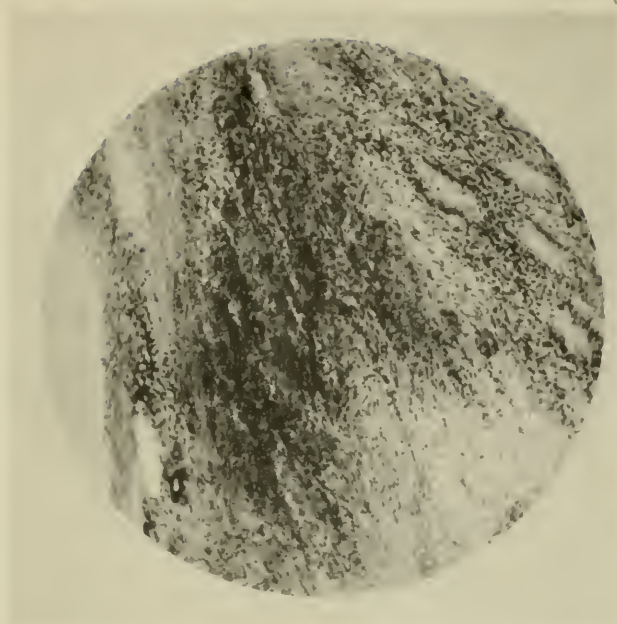


FIG. 1. CASE 1, SHOWING THE ENGORGEMENT OF THE PELVIS WITH BLOOD

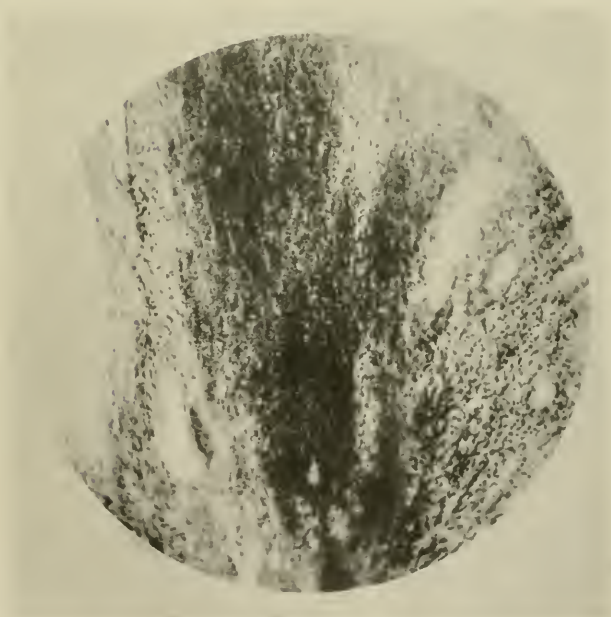


FIG. 2. CASE 1, SHOWING ANOTHER AREA OF THE PELVIS FILLED WITH BLOOD

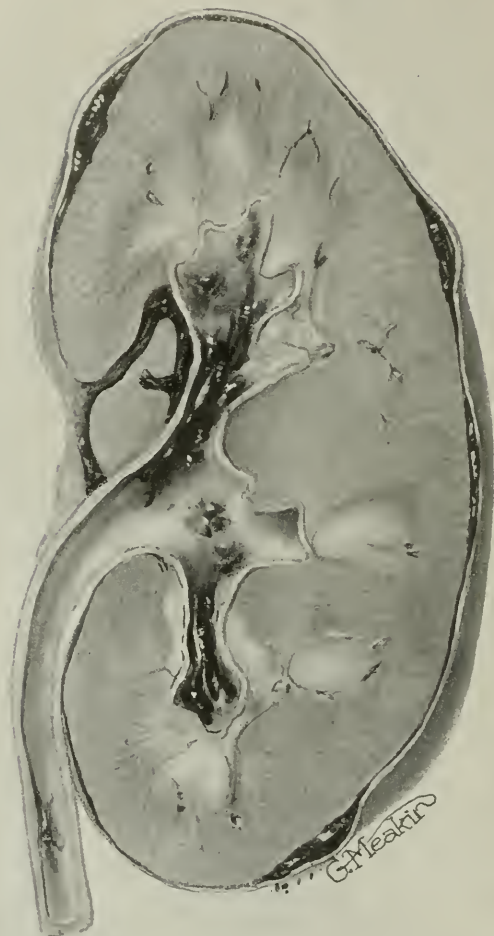


FIG. 3. CASE 1

was entirely negative. The urine was bright red in color and contained few clots. There were no leucocytes or casts. X-ray negative. Cystoscopic examination showed a stream of blood coming from the left

ureteral orifice, clear urine from the right. Both ureters were easily catheterized. The urine from the right kidney was normal. That from the left full of blood. The bleeding was not influenced by the injection of adrenalin. A few days rest in bed did not diminish the hematuria. The hemoglobin went down to 68 per cent (Sahli).

Under nitrous-oxid-oxygen anesthesia the bleeding kidney was exposed. It appeared markedly hyperemic, otherwise negative. Nephrectomy was done. The patient left the hospital on the tenth day, the urine being free from even microscopic blood.

Case 2. Male, age fifty-three, referred by Dr. Lester E. Frankenthal. Patient had been having a profuse hematuria for three weeks before he told any member of his family. Upon entrance to Michael Reese Hospital he appeared very anemic and was very weak.

Except for a gastro-enterostomy one and one-half years previously there was nothing worth noting in his history. He had no pain at any time referable to the kidney. Physical examination revealed nothing. X-ray negative. Hemoglobin 70 per cent (sahli). Blood pressure 105 systolic, 60 diastolic. Cystoscopic examination showed a stream of bright red blood pouring from the left ureter. Clear urine from the right. Both ureters were catheterized.

Two weeks rest in bed lessened the hematuria somewhat. Finally consent for operation was obtained.

The exposed kidney showed marked hyperemia at the lower pole, boggy to the touch. Gentle pressure squeezed a large amount of blood through the capsule at this point. The remainder of the kidney appeared normal. Nephrectomy was done. Convalescence was uneventful, the patient leaving the hospital on the eighth day, the urine being free from blood.

PATHOLOGY

On splitting the kidney of case 1 the pelvis was seen to be engorged with blood which extended up and around the entire kidney between the capsule and the parenchyma; the ramifications of the calyces were filled with blood. Otherwise the organ appeared entirely normal, the structures standing out well.

Case 2 showed marked hemorrhage into the parenchyma at the upper pole, finally disappearing about the mid-third of the kidney into the pelvis.

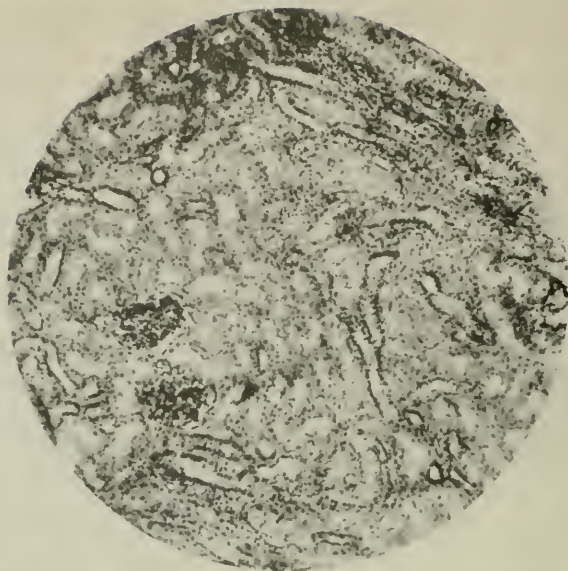


FIG. 4. CASE 2, SHOWING THE HEMORRHAGE INTO THE GLOMERULI AND INTER-TUBULAR TISSUE



FIG. 5. CASE 2, SHOWING THE EXTENSION OF THE HEMORRHAGE INTO THE CAPSULE
Note the normal appearance of the tubules

Several hundred sections from each specimen taken at various points show, microscopically, in case 1 the bleeding most profuse



FIG. 6. CASE 2

in the pelvic supporting tissue and into the larger divisions of the calyces, extending around the kidney sub-capsularly. There is also considerable engorgement of the intertubular connective

tissue but the tubules and glomeruli are practically free from blood. There is absolutely no round-cell infiltration and no degeneration of the tubular epithelium there is also no fibrous tissue formation.

Case 2 gives a somewhat different picture; here the collection of blood is markedly inter-tubular and intra-glomerular, the former more pronounced. The pelvic tissue also contains accumulations of blood and many of the pelvic blood vessels are engorged. Again there is a total absence of involvement of the tubules and no evidence of any fibrous tissue.

Conclusions are warranted that these two cases belong to a classification of renal pathology the etiology of which is as yet unnamed.

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DISCUSSION

Dr. HERMAN L. KRETSCHMER: I was glad to hear Dr. Koll condemn the use of loose terms, such as essential hematuria and idiopathic renal hemorrhage, terms which I believe belong to the Dark Ages. In the past, when kidney surgery was in its infancy, and cases were not thoroughly studied, the inability of clinicians to find the cause for the bleeding, led to the use of these terms which mean absolutely nothing. Since the advent of modern diagnostic measures, these cases are diminishing very rapidly in number.

All of us have been in exactly the same boat as Dr. Koll, in which all diagnostic measures have been exhausted and nothing been found to explain the bleeding. Operation is resorted to, as in his case, and "apparently" a normal kidney is taken out. It seems to me there is one point Dr. Koll brought out which deserves great emphasis, and that is that possibly some pathology exists which has been overlooked. This I think is most significant and no doubt happens quite frequently in cases in which it is stated that nothing is found. I remember an article by a Swiss physician who reported a case first as essential hematuria because nothing was found to account for the bleeding. The kidney was removed and careful study of it showed a small amount of papillary tuberculosis.

I remember one instance of a patient we had at the Presbyterian Hospital and for whom everything was done, including pyelograms and we were unable to arrive at any conclusion regarding the cause of the hemorrhage. After being under observation for about ten days the patient died early in the morning of a cerebral apoplexy. We were fortunate in obtaining an autopsy at which time a typical bleeding pyelitis (pyelitis granulosa) was found. I have often wondered whether the etiological factor that produced hemorrhage from the pelvis of the kidney had anything to do with the attack of apoplexy.

I think Dr. Koll is to be congratulated for reporting these two interesting cases and again in bringing up this question of kidney hemorrhage without any apparent reason for the bleeding.

Dr. GUSTAV KOLISCHER: The problem Dr. Koll has presented simmers down to the question of diagnosis, for unless we can arrive at a proper diagnosis we cannot institute a rational therapy.

As to the possibility of early tuberculosis, it was pointed out years ago by Madelung, who published his observations on essential hematuria. These cases were observed for a while and subsequently showed marked tuberculosis. There is no doubt the hemorrhage was due to tuberculosis. The question is not infrequently asked, is it possible to make a diagnosis of incipient or latent tuberculosis of the kidney? I think it is. We will quite often find cases of occult bleeding and none of the usual changes of tuberculosis around the ureteral opening. If you administer to such patients a small dose of tuberculin you will find pronounced vesical changes and tubercle bacilli in the urine during the period of reaction.

As to the source of hemorrhage, we have to differentiate between a hemorrhage that comes from the pelvis and the kidney parenchyma, but this is quite often not done. There is an idiopathic form of pyelitis which does not involve the parenchyma of the kidney. These cases were proven by examination of the kidneys that were unfortunately removed and a tremendous hemorrhagic pyelitis found. Is it possible to differentiate these two conditions? It is possible by functional tests of the kidney; I do not mean color tests, but functional tests by overburdening the kidney. If the parenchyma of the kidney is not involved the hemorrhage must come from the kidney pelvis. If we exclude, as Dr. Koll did, all the cases of pronounced infection, stones, tumors, and so on, we still will find cases of involvement of the kidney which will lead to hemorrhage. One condition is glomerular nephritis. You will find many case of nephritis with considerable hemorrhage which will almost exsanguinate the patients. You will find that if a patient is suffering from glomerular nephritis, flushing out the kidney and forcing liquid into

the patient may do damage. If you have inflamed glomeruli and an overburdened circulatory apparatus, and you fill the kidney with fluids you are likely to increase the hemorrhage and do no good. We are successful in most cases in checking a glomerular nephritis and subsequent hemorrhage by putting the glomeruli at rest as in any case of congestion and inflammation. It is possible to make a diagnosis of glomerular nephritis. One of the main symptoms is a rapid rise in blood pressure. In infants we may have a blood pressure of 200. If there are perinephritic disturbances, we succeed in many cases in stopping the hemorrhage by the decapsulation of the kidney. The superficial foci of inflammation are exposed and drained. We find quite often that so-called occult hemorrhage of the kidney is based on a process that occurs outside of the kidney. If due to some old perinephritic process, for instance, the pelvis is distorted. We find occasionally spasmodic contractions of the pelvis and ureter, and subsequent hemorrhage after such a renal attack.

A valuable addition to our knowledge about hemorrhages from the kidney was made during the war. It was found that soldiers developed orthostatic albuminuria on standing for quite a while and also showed blood in the urine, but this disappeared if they were put at rest without any physiologic disturbance. The edemas disappeared, and while occasionally blood would appear in the urine it would finally subside.

The traditional differentiation between parenchymatous nephritis and interstitial nephritis should be abandoned to a great extent. We classify inflammatory diseases of the kidney in accordance with the place of origin. By making real physiologic tests of the kidney we can make a diagnosis. If you put the kidney to excessive demands you will find pathology and you will know what you have to do. Rational therapy is based on a correct diagnosis. Unfortunately there is still too much stress laid on the color tests. Nobody has proven that elimination of stains is identical with the physiological or biological function of the kidney. There may be cases in which we have to remove the kidney on account of excessive hemorrhage, but these cases are rare. If we try to arrive at a real, rational diagnosis and

adjust our therapy to the conditions found and not to preconceived ideas, we will accomplish a good deal.

Dr. VICTOR D. LESPINASSE: My views on the subject of idiopathic hematuria are not exactly orthodox. I have always been impressed with the point that a hemorrhage from the kidney was more a chemical process, something that has to do with the general metabolism and general chemistry of the body in relation to the kidney, than it had to the kidney itself, and that the treatment by nephrectomy, as recommended by surgeons and urologists, was too heroic.

In the diagnosis we can run through every test we have, and the problem simmers itself down to whether it is tuberculosis, tumor, or so-called essential hematuria. It has been my practice to temporize, to let them bleed and transfuse them and keep on transfusing as long as I feel sure the case is not tuberculosis, or tumor, or there is no real reason or any great suspicion of it. If there is, an exploratory operation will rule out the tumor side of it, but will not rule out the tuberculosis side. When you have a kidney exposed that has been bleeding for months maybe, with subcapsular hemorrhage, decapsulate it and let it go. We have had four cases treated in that way and the hemorrhage has stopped, and these patients still have their kidneys. I do not think it is consistent with good surgical principles to sacrifice these kidneys unless they bleed to such an extent that the patients are in danger of death from acute hemorrhage. To nephrectomize cases of this sort, where the blood picture is pretty well up, is not good surgery.

Dr. H. GIDEON WELLS: I wonder if in these cases in which the kidney has been removed for so-called essential hematuria it has been the practice to make careful dissection of the blood vessels to show you are not dealing with infarction.

In the second kidney passed around my first impression is that it looks like a kidney that has obstruction in the circulatory system. Certainly, obstruction in the main renal veins can produce profound hematuria and will recover nicely through the collateral

circulation. That is the first thing that occurs to me since hearing the discussion of Dr. Lespinasse, and as it would appear black under the capsule it makes me think of the possibility of vascular obstruction.

Dr. VINCENT J. O'CONOR: I have had the opportunity of studying twelve of these cases in which, unfortunately, the kidney was removed for profuse bleeding. We studied them carefully from a microscopic point of view. The lesion was different in the main, that is, in some instances it was entirely a subpelvic affair, such as Dr. Kolischer described, in which there was an accumulation of extravasated blood beneath the renal papilla, with a slight erosion of the mucosa and the escape of blood into the pelvis of the kidney in that way. In several of these cases there were localized areas of scar tissue in the parenchyma of the kidney which apparently affected some of the tubular epithelium.

In a recent case which I followed very closely, a woman had a very profuse hematuria (bilateral). I studied her carefully from a renal function point of view for the purpose of determining the specific gravity of the urine from each kidney, the amount of fluid, the amount of blood urea nitrogen as well as the divided phenolsulphonephthalein. In this woman there was no sign of decrease in function from either kidney although she continued to bleed profusely. The patient was examined carefully. She had a slight catarrhal condition of the colon which was corrected, but the bleeding continued. At no time was there a positive culture of the urine. Having exhausted all the usual textbook and literature methods of stopping the hemorrhage, I tested the coagulation time of the blood and found it was fifteen minutes. Shooting in the dark, I gave a large amount of serum and for a period of a month the hemorrhage ceased. From time to time, in the last five months, she has had some microscopic blood. Whether that is a question of coagulability of the blood, I do not know.

Like Dr. Koll, we are trying to find some method of diagnosing these cases.

Another case was that of a doctor who had a left-sided renal hematuria, with absolutely no pathological findings. X-ray showed a slight enlargement of the spleen; the lower pole of the spleen pressing down upon the upper pole of the kidney. This was definitely shown by making pictures in various positions, and the pyelograms and all urinary tests were normal. I dismissed that case with the feeling that possibly the pressure condition on the kidney might be responsible for allowing red cells to go through.

In a case of carcinoma of the kidney a man voided urine which was absolutely clear. On allowing the urine to stand one-half of it became jelly-like, absolutely coagulated. It was a new thing to me, and I thought there was something in the urine bottle. Half of the urine he passed was absolutely clear but coagulated. While there were a few red corpuscles, there was no turbidity or redness of the urine. In following up this case it was found the patient was passing fibrin through the kidney without the presence of gross hematuria. I found then that fibrinuria was caused by the filaria in the tropics, which is a common thing, and spontaneous coagulation of the urine in the tropics is quite common in those who have filariasis. There are only 25 cases in the literature of the passage of fibrin from the kidney, one-half in cases of carcinoma and the other in nephritics in whom there was an opening up of the threshold in the kidney. These cases should not be confused with a diffuse glomerular nephritis. In some cases the process is a localized one, in others a subpelvic one, which does not involve the glomeruli or a large number of the tubules; it does not diminish the secretory (or filtration) function of the kidney. Therefore the functional power is not decreased to the extent of determination by any of our present laboratory methods. I do not think in the cases I have seen there has been any marked lowering of the renal function due to the type of lesion mentioned. In many of these cases when the type of lesion could be checked back after operation, we found people having foci of infection which should have been corrected before operation. In these instances the infection is sub-mucosal and of very low grade, therefore negative cultures are most often obtained on urinary examination.

Dr. CHARLES MORGAN McKENNA: Dr. Wells made an important point when he spoke of infarction of the kidney. I have contended for some time that essential hematuria was either due to an infarction of the kidney or of some lesion or tumor in the posterior urethra.

I recall in 1912, a case of a boy nineteen years of age, whom Dr. Kolischer saw with me. He had periodical bleeding for some time without apparent cause. I did an exploratory on this case, split the kidney and the infarct was very evident. It was just a question at the time of operation whether it was an infarct or tuberculosis. The lesion, however, was excised and the kidney sutured, the same as in any other kidney, and the patient made an uneventful recovery without having any symptoms afterward. The catheterized specimen showed no tuberculosis.

Another case was that in a boy twenty-one years of age who gave a history of syphilis. While the blood Wassermann was negative, spinal fluid was positive. This was an interesting case inasmuch as the boy came to the hospital in terrific pain in the right kidney and was passing blood from the bladder. Before a cystoscopic examination could be made, he vomited and passed a great amount of blood. At that time a diagnosis of syphilis had not been made. The hemorrhage from both the kidney and stomach, which were explained by Dr. George Dick, were due to syphilitic granulations breaking off from the heart valve, one lodging in the kidney and the other in the stomach wall, hence producing a hemorrhage. Of course, this was a very acute thing but I think it brings out the point of how an idiopathic hemorrhage can take place in a less acute condition. In fact, any infection elsewhere in the body may be the real starting point which finds its way to the kidney and thus produces a hemorrhage.

Dr. KOLL (closing): In answer to Dr. Wells' question I will say that the question had suggested itself whether or not this was an infarct. To that end we made a careful examination to see whether there was any evidence of obstruction. The few men who have reported these cases, where they have been based on real microscopic examination, have mentioned the fact of the

possibility of some obstruction to the venous circulation being a causal factor.

Dr. O'Connor's experiences are exceedingly interesting, and I would strongly urge the publication of his twelve cases. It would be a distinct contribution.

OBSERVATIONS ON INTRARENAL PRESSURE

A PRELIMINARY REPORT¹

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No thoughtful urologist can approach the proposal of a pyelogram in any given case without a mixture of feelings. On the one hand stands the fact that it is a method which cannot be replaced, there is no other way of attaining the same result for diagnosis; and yet, against this fact, stands the unpleasant thought that many cases have died as the immediate or remote result of a pyelogram and have died under conditions which have not been on the whole satisfactorily explained.

Most cases which have come to autopsy have been cases in which a silver compound has been used and this silver compound has been found throughout the various organs, in some localities blocking the bloodvessels completely. In other cases (1) a rupture of an hydronephrotic sac has occurred, with escape of the solution into the peritoneal cavity, peritonitis and death; in other cases (2) death has been attributed to a reflex inhibition of the heart, caused by the pain from distention of the renal pelvis; in other cases a complete, or practically complete anuria has followed the injection of one kidney (3). Still again the view is expressed that the secondary retention of the substance used, due to ureteral obstruction, is the cause of most of the deaths that have been reported from pyelography (4).

Urologists have reached one important practical conclusion as a result of these experiences and of the experimental work which has been done, i.e., pressure should be avoided during the injec-

¹ Read by invitation before the New York Academy of Medicine, Section on Genito-urinary Surgery, May 17, 1922.

tion; nevertheless, it is not clear along what path even excessive pressure acts and it has been found that substances can be absorbed by the kidney under conditions where no pressure is used; as in the experiments of Macht (5), who showed that certain poisons can readily be absorbed from the ureter and the kidney pelvis. But what is the path followed, the secretory system of the kidney, the tubules and glomeruli or the lymphatics? Some workers conclude that substances gain ready entrance to the tubular system; others (6) conclude that substances pass into the lymph-spaces and vessels primarily and appear in the tubules as a secondary, secretory phenomenon.

It would seem, then, that there are many things which are not sufficiently clear to enable the thoughtful urologist to reach that degree of knowledge which alone can bring practical assurance and peace of mind. Some of the problems have been approached, the results not always agreeing; some have not been approached at all; some have been approached from only one side.

Thus the problem of the toxicity of the solution upon the body as a whole has been attacked, with the result that concentrated solutions of the halogen group are being used in place of the more toxic solutions of the silver colloids. Yet we find no discussion of the comparative effect upon the kidney itself of a concentrated crystalloid solution, which must exert a very great osmotic pressure upon the tissues with which it comes in contact and the effect of a colloid of low osmotic pressure.

We find no discussion at all of another possible factor; it is known that the exposure of the skin to the X-ray renders it susceptible to the irritant action of substances to which it does not ordinarily react; will the kidney react in a similar manner, becoming susceptible to substances to which it would not normally react because of the exposure to the X-ray?

The cases of anuria following the pyelography of one kidney suggest the following question: it has been shown that the section of a normal nerve is followed by degenerations, not only of the sectioned nerve, but of the corresponding, untouched, normal nerve on the opposite side; can the function of a normal

kidney be reflexly inhibited by some influence at work in the opposite organ? We believe we can answer this in the affirmative from clinical experience.

It has been the observation of all urologists to note cases of crossed renal reflexes, that is patients complaining of pain on one side, with demonstrated pathology only on the opposite side. We believe also that there is encountered at times cases with crossed reflex inhibition of function, at least so far as the kidney's ability normally to excrete certain foreign substances is concerned, as illustrated by the following cases: About four years ago there was admitted to one of our hospitals a young woman complaining of vesical irritability. Cystoscopy revealed a typical tuberculous cystitis, with unmistakable evidence of involvement of the left ureteral orifice from which a very purulent urine was being eliminated. Both ureters were catheterized and the patient given an intramuscular injection of indigocarmin of the usual amount. From the left side purulent urine loaded with tubercle bacilli was obtained, which after a few minutes became admixed with a considerable quantity of the dye. From the right side a perfectly clear and copious amount of urine was collected, which contained no pus, tubercle bacilli or indigocarmin for a period of twenty-five minutes. Left sided nephrectomy was followed by a remarkably satisfactory convalescence. In a second case recently of a forty-eight-year-old man, complaining of pyuria, cystoscopy revealed evidences of an early tuberculous cystitis and catheterization of the ureters followed by the usual intramuscular injection of indigocarmin, demonstrated a slightly purulent and bloody urine from the left side, loaded with tubercle bacilli; from the right side a perfectly clear urine free of pus or tubercle bacilli was obtained. No dye appeared from either side for twenty-two and one half minutes.

Can pressure in the kidney pelvis produce inhibitory reflexes upon the heart?

These are some of the points we had in mind in approaching the problem.

A good deal has been written concerning the danger of using too great pressure during the injection; the idea advanced to explain

certain clinical cases, that of reflex inhibition of the heart, has not been submitted to experimental test, as far as we have found; yet the shock and collapse which characterizes certain cases of kidney colic suggests the possibility that a similar condition could be experimentally produced by too great distention of the renal pelvis.

Our first experiments were directed toward this point. Dogs were attached to the ordinary recording apparatus and a kymographic record made of the respiration, blood pressure and the injection pressure. The pressure in both kidney pelves was then increased by appropriate means and the effect of different pressures upon the reflexes watched. We found that pressure alone did not produce the slightest effect upon the respiration or the blood pressure of the etherized dog, if the pressure was increased by the use of a non-toxic solution such as normal salt solution. A pressure as high as 400 mm. of mercury causes no general symptoms; but a surprising amount of salt solution runs into the kidneys at this pressure.

On looking into this question of the rapid flow of salt solution into the kidney, we found that at pressures of between 150 and 200 mm. of mercury, the pelvis of the kidney ruptures, and that this tear extends across the venous system of the organ in such a way that the fluid injected into the pelvis flows directly into the veins of the animal; the injection into the kidney pelvis has become a direct, intravenous injection.

If one injects a fresh kidney with a suspension of carbon particles at low pressure, injecting through the ureter, clear fluid will escape from the vein; the kidney acts as a filter. If one injects in the same manner a kidney which has been ruptured by intrapelvic pressure, the carbon suspension flows freely from the vein, showing the direct connection between the venous system and the kidney pelvis; or, the injection can be reversed, when fluid passes freely from vein to kidney pelvis.

If we now substitute for the normal salt solution a toxic solution, such as concentrated sodium citrate, we find that no symptoms are to be seen until the pressure has reached a height sufficient to produce a tear in the kidney substance, whereupon the

fluid, passing into the veins, produces the characteristic effects, in the case of the citrate solution, rapid heart death. No symptoms appear until the point at which rupture occurs.

As far as our own minds are concerned, these experiments, insofar as they pertain to the problem, have cleared up the situation in a way more satisfactory to us, at least, than do any of the experiments we have found recorded in the literature; pressure alone does no harm, that is, no harm in the sense that the dilatation of the kidney pelvis can produce the condition analagous to the clinical condition of the shock and collapse of kidney colic; pressure can do harm in that it can cause a tear of the substance of the kidney, which tear extends directly across or into the venous system of the kidney, and thus affords a direct communication with the venous apparatus of the body. Any substance of a general toxic nature will act as if it were injected into a vein of the arm; collargol, for instance, may then form an embolus, or perhaps more accurately may block the vessels of the lungs or the coronary arteries and cause immediate death.

What, then, shall constitute a harmful pressure? In our experiments it has required a considerable pressure, though not greatly exceeding the normal blood pressure, to produce this tear of the kidney substance. Our feeling has been that this tear was not so much a pressure tear as a tear due to stretching or overfilling of the pelvis. Suppose the kidney is diseased; it follows that rupture of the pelvis may occur more readily and clinically we have come to realize that in certain pathological conditions of the kidney, pyelography is a more dangerous procedure than in others, if not absolutely prohibitive. We find in the literature a case where collargol had penetrated to the renal capsule after only 2 or 3 cc. had been injected (7).

The probable ease of rupture of a diseased kidney and the direct connection between the tear of the kidney substance and the veins which we have shown, would seem to make it fundamental to not only avoid all pressure but at the same time to use the least toxic substance available; and yet we feel that the problem of colloid or crystalloid is not yet settled.

But now another question arises. Having ruled out pressure and consequent rupture, it has been shown by a number of workers that substances of different kinds can be readily absorbed from the pelvis of the kidney and that these substances are taken up or are found in the tubules of the kidney; even particulate matter can be found in the glomerulus. By what path does this resorption occur?

Our experiments along this line have led us to the same point to which a study of the literature will lead, i.e., mostly nowhere! We believe that this is due to the fact that differences will be found depending upon the nature of the substance used; particulate matter, such as carbon particles, will possibly follow one path; colloid materials will perhaps follow the same path as particles; true solutions may follow a different path.

We have found it necessary in our experiments to go back to the very beginning and study the problem from this point of view and our results along this line are incomplete. We have reached the general conclusion that there is much to be learned about the kidney.

We have ventured, nevertheless, to present our line of thought in approaching the problem, hoping that such a presentation might serve to call forth helpful criticism from those who are especially interested in this line of clinical work.

We also wish to acknowledge due credit to Dr. W. I. Min. Hsu, one of our graduate students in urology, for much laborious, painstaking and conscientious work, under our direction, in performing autopsies, preparing the dogs and observing and recording the details of experiments.

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CARBUNCLE OF THE KIDNEY¹

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By carbuncle of the kidney is meant an infection of the kidney by staphylococci, secondary to an infection elsewhere by this organism, such as a carbuncle or felon, in which the lesion of the kidney has the gross appearance of a carbuncle as seen in other parts of the body.

Although the term "carbuncle of the kidney" is not in general use, there is no doubt in my mind about its clinical entity. This term is not a new one but it is used very infrequently in describing this lesion, Barth, Eisendrath and Isreal having used this term in their writings on this subject.

Carbuncle of the kidney should be differentiated from the acute septic or embolic kidney in which the entire organ is studded with small miliary abscesses, as well as from renal abscesses, either solitary or multiple. It is my opinion that a lesion may start as a carbuncle and the entire area involved undergo suppuration, resulting in the production of large abscesses, single or multiple. If an operation is done early, a picture of typical carbuncle is seen; but when operated upon late in the course of the disease, the picture of abscess, either single or multiple, is encountered. There can be no doubt that one form may merge into the other. This was clearly illustrated in case 2 reported in this paper, when at operation the lesions were typical of carbuncle, but months later, at autopsy, were those of abscess formation in the remaining kidney.

Carbuncle of the kidney is a metastatic lesion being similar in its origin to the acute septic kidney and perinephritic abscess; which means that there is or was present a lesion elsewhere in the

¹ Read at the annual meeting of the American Urological Association, Atlantic City, April 26 to 28, 1922.

body from which point organisms were transplanted to the kidney via the blood-stream. Often this lesion is obvious; at times, however, it is not. The patient fails, in a number of instances, to tell us of previous attacks of boils, for the reason that he does not think "they amounted to very much" or because he is well of them and has completely forgotten about them. Again, the lesion of the skin may have been so slight that it healed without the patient being aware of its existence, such as lesions between the toes, eczema, etc. Occasionally, even when a carbuncle has occurred, the attending physician may overlook the relationship between the carbuncle and the kidney lesion—to my mind a most significant fact.

The predisposing lesions in the two cases reported in this paper, were an osteomyelitis of the last phalanx of the right thumb in one case and a carbuncle of the neck in the other case.

Phemister has recently called attention to the importance of lesions of the skin in the production of acute osteomyelitis, emphasizing the fact that the skin as a focus is so often overlooked, often forgotten and just as often neglected.

Having recently had two cases of carbuncle of the kidney under observation, one unilateral and the other bilateral, in which the primary foci were demonstrable, and since the literature of this country is not characterized by reports of numerous cases of this type, the following two cases may not be without interest.

Case 1. Mrs. H., aged thirty-five. Referred by Dr. T. E. Roberts. Admitted to the Presbyterian Hospital, October 25, 1920.

In March, 1920, seven months before coming under observation, the patient developed a felon of the right thumb which was incised. One month later a piece of necrotic bone was removed, and on April 27, while the thumb was still suppurating, she gave birth to a child. About June 7 she experienced an acute pain in the left side, which remained localized. A physician made a diagnosis of prolapsed kidney and she was instructed to wear a pad. The pain was not associated with urination, was dull in character and constant since its onset. Abdominal colic was so intense that she was compelled to double up to get relief. Nausea about half an hour after eating. Frequency of urination; voided about five times during the day and once at night. Urine very brown in color.

Physical examination. Head, neck, heart and lungs, negative. The left half of the abdomen, very prominent and full. In the upper left quadrant a large, hard, irregular mass was palpable, slightly movable upon respiration, and very tender on pressure. Pressure over the back produced a sharp pain, extending into the groin. The mass was compatible with an enlarged, tender kidney. Both upper and lower poles were palpable. There was an old healed felon of the right thumb.

Blood examination. 14,400 leucocytes and hemoglobin 75 per cent.

X-ray examination. Negative for stone.

Cystoscopy, October 26, 1920. Bladder and ureteral orifices normal. Right ureter catheterized easily and a flow of clear urine obtained. Left ureter easily catheterized but no flow obtained. Urine from the bladder and right ureter negative for pus cells. Cultures showed the right side sterile and colon bacilli in the bladder. Stains for tubercle bacilli were negative.

A mixed phenolsulphonaphthalein test showed an output of 58 per cent in thirty minutes.

Operation, November 4, 1920. The usual oblique lumbar incision was made in the left side and the kidney exposed. The kidney was firmly bound down by thick adhesions and because of these it was difficult to free and deliver the kidney. The tissues around the kidney were somewhat edematous. Ureter was ligated and cut about 1 inch from the pelvis. The pedicle was clamped with two clamps and the kidney removed, then the pedicle was ligated and the clamps removed. Muscles were approximated with heavy gut and cigarette drains were left in place. Patient made an uneventful recovery.

Gross description. The kidney was about one-third larger than normal and the anterior surface, in one or two places, irregularly nodular. On section the cortex was 6 mm. thick and retained its markings with the exception of several large abscesses, which contained thick, greenish-yellow pus, situated mostly in the anterior half. *In close proximity to the larger abscesses were seen several smaller areas that had the appearance of typical carbuncles.* When these areas were pressed, thick, greenish-yellow pus came to the surface. The posterior surface was smooth and the fibrous capsule very much thickened. The pelvis of the kidney was negative.

Cultures of the pus from the abscesses showed hemolytic staphylococci.

At the time the patient came under observation the felon had completely healed; hence it was not possible to obtain cultures to determine

whether or not the organisms found in the kidney were identical with the organisms which produced the felon.

Case 2. T. C. male, aged thirty-four. Referred by Dr. Weigan and Dr. Benson and admitted to the Presbyterian Hospital, September 15, 1921.

During the first week in June, 1921, patient had a carbuncle of the neck which was incised and drained on June 11. When admitted to the hospital the carbuncle had completely healed.

August 8, he complained of slight pain in the lower abdomen; perspiration profuse; temperature of 104.6°F. He was admitted to another hospital where he remained until August 21, and then went home.

August 29, his temperature rose suddenly to 102°F.; severe nausea and vomiting. Another attack of fever on September 3, at which time he first noticed that his urine was bloody. The hematuria lasted for three days and was associated with painful urination. Frequency of urination was also present; voided every one and one-half hours during the day and every two hours at night.

Patient came under my observation on September 15.

Physical examination. Negative with the exception of the right kidney which was slightly enlarged and tender both in front and behind; some rigidity of the lumbar muscles.

X-ray examination. Negative for stone.

Blood chemistry. Sugar, 142.00 mgm., urea, 27.00 mgm., uric acid, 4.40 mgm., creatinin, 1.70 mgm., non protein nitrogen 43.00 mgm.

Cystoscopy, September 20, 1921. Bladder and uterual orifices normal, and ureters were easily catheterized. Cell counts and cultures were as follows:

	CELLS (LEUCOCYTES)	CULTURES
Bladder.....	10	Staphylococcus albus
Right kidney.....	130	Sterile
Left kidney.....	60	Sterile

Functional test. An output of 26 per cent from the right side and 20 per cent from the left side in thirty minutes.

Blood examination, September 22, 1921. 16,800 leucocytes. Two Widal tests, negative.

Cystoscopy, October 6, 1921. Bladder and ureteral orifices negative. From the left catheter a flow of golden yellow urine was obtained; from

the right side, a very rapid flow of very pale urine, containing a large amount of pus shreds.

Pyelogram. Twenty cubic centimeters of sodium bromide was injected into the right catheter. Pyelogram showed traces of the solution apparently extending from the twelfth dorsal to the second lumbar vertebra. Moderate dilatation of the right ureter with some deformity of the pelvis. Cell counts and cultures made at this time were as follows:

	CELLS (LEUCOCYTES)	CULTURES
Bladder.....	110	Staphylococcus aureus
Right kidney.....	1050	Staphylococcus aureus
Left kidney.....	230	Sterile

Operation, October 11, 1921. The usual oblique lumbar incision was made over the right side; muscles and perirenal structures very edematous; fibrous capsule very thick and slightly edematous and much evidence of *perinephritis*; inflammatory thickening of the kidney pedicle. A large carbuncle, located nearly at the middle of the surface of the kidney, was noted. Two large clamps were placed on the pedicle, ligation with heavy catgut followed and the kidney was removed. At the end of forty-eight hours the clamps were removed.

Gross description. The specimen is a large right kidney weighing 200 grams. It measures 13 by 6 by 4.5 cu. mm. The surfaces are smooth, glistening, and very dark red. Near the center of the posterior surface is a mass, somewhat nearer the upper than the lower pole. It is 4 by 3.5 cu. mm. and protrudes 0.5 cu. mm. from the surface. In this mass near the margin are six small swellings, red at the base with a white cap, each from 2 to 5 mm. in diameter. The cut surface of the kidney shows the cortex fairly pale, and in the medulla, at the center of the kidney, are many small, white opaque areas, irregular in form and irregularly distributed. They are all contained in an area 4 by 3 cu. mm. which corresponds to the swellings on the posterior surface. This shows many small isolated abscesses which upon cut surface has the gross appearance of a carbuncle seen, for example, on the back of the neck.

Sectioning shows normal renal tissue, in certain parts of which are sharply demarcated regions, staining a faint blue and characterized chiefly by poorly staining fragmented nuclei and cytoplasm, the latter being quite granular and without cellular walls. A few polymorpha-

nuclear leucocytes are found in and around glomerular tufts and in the interspaces between the tubules. These tubules are filled with a blue-staining homogeneous material and the blood-vessels are engorged with red blood cells. A section from another portion of the kidney contains many polymorphonuclears distributed fairly uniformly throughout the entire section, some of them being in the lumen of the tubules among fragmented red blood cells. These tubules have rough epithelial walls due perhaps to partially desquamated epithelium.

Pus from the abscess showed cultures of pure staphylococcus aureus.

Post-operative course. A moderate amount of shock followed the operation for which the patient was given rectal drip containing soda bicarbonate and 5 per cent glucose. Two ampules of digifolin were given by intramuscular injection. The drains were removed on the fourth day and small iodoform wicks placed in the wound. At the end of three weeks there was no discharge but the wound was kept open because the temperature persisted. Immediately after the operation the patient's temperature subsided so that it was normal in the morning and only 99.2°F. in the evening. This continued for about ten days when he again had a rise in temperature, going as high as 103°F. The temperature curve was very irregular.

The amount of drainage from the wound being very scant and since there were no other findings to explain the temperature, the possibility of some deep-seated infection in the wound was discussed. The wound was reopened but no pus was found. The second operation did not influence the course of the temperature in any way and continued to vary from 98.8° to 102.4°F.

We were particularly concerned with the cause of this continued high temperature and on November 17, Dr. Herrick was called in consultation. His findings follow:

"Patient is pale. Heart enlarged to the left; a loud systolic murmur present, evidently of organic origin. Chest negative except for a few scattered râles at the right base, and anteriorly the hepatic dullness is 2 inches higher than normal. Abdominal examination, negative. No enlargement of the spleen. One or two doubtful petechial spots over the right arm and chest."

Examination by Dr. Herrick on November 26 showed patient less ill than at previous examination. The heart was the same as before. Another examination on December 15 showed heart and lung condition negative. The spleen was plainly palpable and there was a question whether or not the kidney was palpable.

As the fever continued and as the patient had an organic heart murmur, the possibility of malignant endocarditis was considered and blood cultures were made. During the course of three weeks, five sets of blood cultures were made, all of which were negative.

The possibility of subphrenic abscess was also considered, but this was excluded by physical signs and roentgenograms. Since the temperature and leucocytosis could not be explained on the basis of infection elsewhere in the body, and taking into consideration the fact that the right kidney was removed for a carbuncle, the possibility of infection of the same type in the remaining kidney was considered and strongly suspected. The various blood cultures, Widal tests and examinations for malaria were carried out, not so much with the object of finding some remote cause for the temperature as it was to exclude these causes.

During the entire period of observation the urinary findings are of interest. Needless to state many urinalyses were made. After his nephrectomy all the urine voided was practically clear to the naked eye. Some of the reports showed a few leucocytes.

	<i>Leucocytes per cu. mm.</i>
November 29, 1921.....	40
November 30, 1921.....	28
December 5, 1921.....	50
December 8, 1921.....	Few
December 11, 1921.....	70
December 13, 1921.....	30
December 14, 1921.....	110

An interesting point is the fact that though the patient was seriously ill, was running a high temperature and had a high leucocytosis, yet his urine was perfectly clear and the cell count showed only 30 to 110 pus cells per cu. mm. In one culture a few colonies of staphylococci were found. These were so few and the other cultures made before and after that particular culture being negative, a contamination was considered.

The patient left the hospital on December 19, seemingly much improved. At the time of his discharge the entire situation was again discussed and it was agreed that the cause of his high temperature and high leucocyte count was due to an infection in his remaining kidney and that in all probability it was of the same type as that found at operation in his opposite kidney, namely, carbuncle.

The patient was readmitted to the hospital on January 20, 1922, with a small discharging sinus in his wound. After being at home for two

weeks he developed a superficial abscess of his nephrectomy wound from which about 3 ounces of pus were evacuated by Dr. Weigan. During the time he was at home he had an afternoon temperature varying from 101° to 103°F., and once he passed very bloody urine. Prior to the attack of hematuria his urine was clear. Immediately afterward large amounts of pus were found in every specimen examined. Apparently the carbuncle or abscess ruptured into the kidney pelvis since pus was constantly found after the hematuria. At the time of admission to the hospital patient's condition was very critical. The left kidney was enlarged to about twice the size of a normal kidney. On January 28, his blood chemistry was as follows: Urea, 148.0 mgm., uric acid, 13.7 mgm., creatinin, 4.1 mgm., non-protein nitrogen 102.0 mgm.

The patient gradually lost strength and died February 9, 1922.

The autopsy was performed by Dr. Oberhelmen, pathologist to Presbyterian Hospital, and his report is as follows:

"There is a large bulging mass in the left kidney region, larger than the open hand can cover, so that a part of each pole remains exposed. The spleen is huge and bound to the diaphragm behind by strands of fibrous adhesions. That part of the descending colon corresponding to the level of the left kidney is adherent to it by fibrous and fibrinous adhesions for 6 to 8 cm. up and down, and 1 to 2 cm. side to side. One small accidental cut is made into the kidney capsule and from this yellowish-green purulent fluid flows.

"The left kidney is asymmetrical, the bulging being more in front than posteriorly. When cut into, thick, purulent, greenish-yellow pus escapes in a large amount. This pus is contained in small pockets, 3 to 10 mm. in diameter. These are surrounded by a grayish-yellow membrane 0.5 mm. thick. The broad surface made by sectioning these pus pockets, has a honeycomb appearance. These pus pockets involve all the kidney tissue for 8 cu. mm. up and down. The only uninvolved kidney tissue is at either pole, a little more toward the lower than the upper pole. The pus pockets occur in clusters and are fairly well demarcated from the surrounding kidney parenchyma; they impinge on the top of the pelvis but in no place do they perforate it, and whatever pus there is in the pelvis has entered through the papillae of the calyces. The cortex is 1.5 cm. wide where it is not encroached upon by the pus pockets and is bright reddish-brown. It is sharply differentiated from the pyramids which are more red. In the cortex small pinpoint-sized glomeruli appear as glistening points. The lining of the pelvis is

thickened, smooth and pale gray as is also that of the ureter in the lumen in which there are small masses of free pus. The capsule of the kidney is 2 mm. thick and very dense."

SYMPTOMS

The symptoms may be very conveniently divided into three groups: General, local, and urinary.

General

As a rule these patients are severely ill when they come under the surgeon's care, having been ill for a long period of time. Often no diagnosis has been made. The symptoms are those found in any severe, infectious process of an acute or a chronic nature.

Chill. There may or may not be a history of a chill or of chilly sensation. The attack may have been so slight that it is forgotten by the patient or it may have occurred so many weeks before that no recollection remains.

Fever. This is always present and is generally very high. In the cases reported in this paper, temperatures of 101.6°, 102.8°, 103° and 103.2°F. were recorded.

Loss of appetite, malaise, etc. These symptoms which are common to infection are present.

Leucocytosis. This is always present. The highest count in the cases reported here was 22,700 leucocytes. In Eisendrath's case a leucocytosis of 27,000 was found.

Local

Pain in the region of the kidney involved though practically constant, varies in its severity. The pain may be described as cramp-like or cutting. In case 1 the pain radiated from the kidney region into the abdomen.

Localized tenderness. This was present in both cases, making palpation difficult because of the rigidity of the abdominal and lumbar muscles, although in case 2 the remaining kidney was quite easily palpated because of the absence of local tenderness or rigidity. In several instances the side involved was full and prominent.

Urinary

The urinalysis may be practically normal or nearly so. The fact is striking that there is a marked disparity between the illness of the patient and the rather insignificant urinary findings. This can easily be explained from the pathology. Since the lesion is at first confined to the parenchyma of the kidney and there is no communication with the pelvis, the changes in the urine are very slight. In case 2 before his first operation, some pus and staphylococci were found in the urine. These promptly disappeared after the nephrectomy and the urine remained sterile and free from pus for weeks, in spite of the fact that the patient was running a very high fever. In case 1 one specimen showed 25 leucocytes, a second 50 leucocytes, and a third specimen 600 leucocytes per cubic millimeter.

These urinary findings agree with those of Barth, Zinn, etc. In two of Barth's cases the urine was perfectly normal for eight days after operation when pus appeared in the urine. Zinn states that the urine in one of his cases was normal. In some cases a small amount of pus was present. Judging from the case reports the urine contained a number of pus cells (Eisen-drath); a number of leucocytes and erythrocytes (Barth); some pus in the urine from the right and left sides (Furniss) a few pus cells (Fischer); a few pus cells (McWilliams).

These foregoing few citations should suffice to show that the urinary findings are insignificant, especially so in cases of the type in which the patient is severely ill.

DIAGNOSIS

The diagnosis in both cases was made before operation, and to this end a careful consideration of the history is of the utmost importance. The most significant single fact which gives the clue to the diagnosis is the statement from the patient that recently he had a boil, carbuncle or felon. This statement enlightens the physician as to the probability of an infection of the staphylococcus type acting as a focus from which infecting organisms may be transported via the blood stream to the kidneys.

This statement coupled with the fact that the patient has been severely ill, with a high septic temperature, a persistent leucocytosis with an enlarged tender kidney and urinary findings which are negative or practically negative has lead us to establish the diagnosis.

The differentiation between carbuncle and the acute embolic kidney, in which the kidney is studded with small miliary abscesses, may at times be impossible; hence, the diagnosis of an acute suppurative process of the kidney is often made. Likewise, it is impossible to differentiate between a carbuncle of the kidney and a large solitary abscess, which, I believe, may in some instances be the end-result of a carbuncle.

In the cases of small multiple abscesses of the kidney there does not seem to be the same degree of resistance and fixation upon palpation that is present in renal carbuncle.

TREATMENT

In carbuncle of the kidney nephrectomy is the operation of election unless the carbuncle is small and the case is seen early, in which event resection might be tried. Nephrectomy was performed in these 2 cases, since the pathological process was so extensive that nothing short of nephrectomy seemed wise. Nephrectomy was also carried out by Israel, Barth, McWilliams and Zinn.

In reported cases associated with a perinephritic abscess the true pathology probably was not at first recognized, and the abscess was incised. This failed to relieve the symptoms, a secondary nephrectomy being necessary. Cases of this type have been reported by Barth (two cases), also by Furniss, Fischer and Eisendrath.

In cases in which the carbuncle has broken down and gone on to abscess formation and in which a single abscess is present, drainage can easily be instituted.

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NEPHROLYSIS AND URETEROLYSIS¹

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The term nephrolysis was introduced by Rovsing in order to denominate an operation whose purpose is to free the kidney from pathologic conglutinations and attachments. If an operation of a similar character has to be performed on the ureter, then we speak of ureterolysis.

These pathologic encroachments upon the kidney are due to perinephritis, the inflammation of the fatty tissue surrounding this organ. This perinephritis may originate in infectious processes in the renal parenchyma that permeate the fibrous capsule and enter the fatty capsule or they may be indigenous inflammations of the latter. It is known that the vascular system of the perinephrium is independent from the vascular system and thus hematogenous infections may be deposited there, although the kidney proper is not all involved in this process.

After the acute stage has passed the inflammatory infiltrations may become organized and finally be transformed in fibrous, cicatricial tissue. This pathology will preferably be the topic of this discussion.

This fibrous transformation of the perinephritic fat may either lead to a compression of the kidney or the formation of cicatricial strands may attach the kidney to other intra-abdominal organs and may also dislocate the kidney by their progressive contraction or both conditions may be combined.

It is easily understood how the embedding of the kidney into layers of unyielding tissue will produce a variety of subjective and objective symptoms.

¹ Read before the Chicago Branch of the American Urological Society.

It is the task of the kidneys to maintain the optimal most beneficial concentration of the blood. In order to do that it has to adjust itself to the various demands that are put to it by the change of materials that are presented to it in the blood by the bodily metabolism.

Now the functional efficiency of the kidney depends upon the velocity of the blood stream coursing through it or in other words upon the amount of blood that is forced through it during a certain unit of time. Now if the kidney is encased in hard fibrous tissue, an increase of arterial blood will either be obtained by an excessive heart action or if the encapsulation be very hard, the arterial influx will be impaired and then the kidney will lose its elasticity of function, cannot adjust itself to increased demands and a condition develops known as hyposthenuria.

Excessive heart action will show all the very well known cardiac symptoms, while hyposthenuria will manifest itself by the rigidity of the urinary output.

In case the encasing of the kidney extends to the hilus, interference with the venous efflux will result, leading to stagnation inside of the kidney. This condition will manifest itself by the appearance in the urine of cylindroids and in high degrees of stagnation even red blood cells may be found. Under certain conditions acute edema of the kidney may obtain which leads to intensive attacks of pain in the renal region.

Attachment of the kidney by cicatricial strands to the peritoneum and thus indirectly to intestines is apt to produce a variety of symptoms. The respiratory motions of the kidney will pull on the intestines causing intestinal distress, while a plethora of the latter organs will produce renal pain by the traction on this sensitive organ. Many a good result ascribed to nephropexy is undoubtedly due to the severing of such adhesions previous to the anchoring of the kidney.

Next of course the question will arise, whether it is possible to diagnose the conditions above described.

We will arrive at this diagnosis directly by positive interpretation of the clinical findings and by the process of elimination. If the renal region is either the seat of permanent dull aches or if

renal attacks occur periodically especially after increased intake of fluid, if only one kidney, the painful one, is found to be hyposthenuric—and if a history of previous focal infections is to be elicited—then we have to think of a past perinephritis, leading to cicatrization of the perirenal fat. This supposition is confirmed if the urine remains normal or if only during and immediately after the attacks cylindroids or reds are to be found.

Another contributing item will be the discovery by palpation and radiography that the kidney is misplaced.

If in addition to all that no evidence of concretions or of a tumor are to be found, then the diagnosis of a cicatricial perinephrium is pretty well established.

The diagnosis *per se* forms the indication for the therapeutic procedure. The kidney has to be freed from its cicatricial cage and the results are most satisfactory.

One of the most impressive operative results will obtain, if a unilateral infectious nephritis outlasts the acute stage of the accompanying perinephritis. The nephrolysis will do away with the choking off of the kidney while the decapsulation done at the same time will exert its beneficial influence on the nephritis.

In this way the patient is relieved of his sufferings and a cure of the nephritis may be inaugurated at the same time.

It may be mentioned that a nephrolysis is never to be considered completed unless after freeing the body of the kidney, pelvis and pedicle are also exposed and inspected, so that cicatricial compression in this region may also be discovered and relieved.

One of the most frequent indications for ureterolysis is furnished by the distortion of the upper end of the ureter, due to a perinephritis occurring in this region. Two basal types are to be observed. The upper ureteral end becomes either attached to the inner surface of the lower pole of the kidney, tangential attachment, or it becomes drawn up to the inner surface of the upper pole, thus transforming the upper end of the ureter in a loop or fishhook shape. It is evident that such an attachment of the ureter may lead to considerable interference with its function. Any congestion of the kidney will not only compress the ureter and impair its lumen but the ureteral contractions, so necessary

for the prompt propelling of the urine will also be interfered with. This is particularly pronounced if this attachment be of a rather firm character. The attempts of the pelvic and ureteral musculature to overcome such an obstacle may lead to pronounced "renal colics."

The diagnosis of such a pathologic attachment to the kidney of the ureter is as a rule readily made by an appropriate X-ray picture. The course of the ureter if marked by a shadowgraph catheter, will show the intimate proximity of the upper ureteral end to the edge of the shadow of the kidney.

There is a cystoscopic phenomenon that if observed will call our attention to the probability of such an abnormal attachment to the kidney of the upper ureteral end. That is the observation of a delirium of pelvis and ureter if this term is permissible.

The urine is ejaculated into the bladder by rhythmic contraction of the renal pelvis that are transmitted to the ureter. As expression of this contractile wave we observe the jets propelled out of the ureteral openings into the urinary bladder. If on one side these jets appear at regular intervals, while on the other side the intervals between the urinary jets are unduly prolonged and this pause is followed by forcible ejaculations following each other in close order, one has to suspect a pathologic attachment of the ureter.

The renal pelvis in its endeavor to overcome the obstacle becomes unduly excited and the accumulation of this stimuli produces numerous contractions following each other very closely. These contractions are transmitted in the same order to the ureter, producing the cystoscopic phenomenon mentioned above.

It may be safely stated that nephrolysis and ureterolysis represent a distinct advancement in urologic surgery. The results are uniformly good and the operative risk is a negligible quantity. The modern methods of exposing the kidney and its pedicle obtain this without any appreciable destruction.

Nephrolysis and ureterolysis answer the demands of the only surgery, that is thoroughly satisfactory—cure without any mutilation.

DISCUSSION

DR. DAVID C. STRAUS: I would like to report one case in connection with Dr. Kolischer's paper for the reason that Dr. Kolischer did not mention the cause for the fixation of the kidney by scar tissue. I saw a young girl, eighteen years of age, who in the winter of 1920 slipped on the ice, sat down on the pavement, and immediately thereafter was seized with a severe pain in the right lumbar region. I was called to see her that same evening, she was very sick, and found an extremely rigid right abdomen. I had her brought to the hospital at once. The most common injury to a young woman after a severe jolt like that is a rupture of the liver, which occurs more commonly than in any other organ of the body. When a person is caught between two automobiles or is kicked by a horse the most common injury one thinks of is a rupture of the liver.

I examined the urine of this patient and it contained many red blood cells. Her white count was not up. There was no dullness in the right flank or any other symptom except rigidity in the right lumbar region which we may find in the rupture of an intra-abdominal organ. She had a partial rupture of the kidney from the urine examination. In three days she was free from symptoms and sent home. In the course of three days the urine showed that she was having blood after the first day. There was quite a heavy trace of albumen, then a few casts and the urine cleared up entirely. The patient went home free from symptoms and following that day she complained of a constant pain in the lumbar region. I was convinced the pain was due probably to the blood and changes occurring in the blood around the kidney but the urinary findings were negative. There was no evidence of any infection from the hemorrhage. She continued to have pain almost constantly until the following year. I had her urine examined and finally had Dr. Schmidt see her who cystoscoped her. I told him what I thought was wrong and he corroborated

my belief and thought she was suffering from a kidney that had an organized hematoma around it, compressing the kidney. He examined her cystoscopically and found both ureteral orifices normal. He catheterized the ureters and the urine from both kidneys was found to be normal. He advised decapsulation which I did. I made the usual lumbar incision and found the kidney surrounded by an extremely dense fibrous casing. I removed that with ordinary decapsulation and promptly after the operation she ceased having pain in the back and has been free from pain ever since. That is another cause and except for infection the most common cause is a hemorrhage.

Dr. KOLISCHER (closing): I think the cause of perinephritic contraction is the one mentioned by Dr. Straus. Practically every hematoma around the kidney becomes infected. If there is infection, suppuration and thickening, with exudation, you will find cicatrization but the infection is only hematogenous. Trauma has practically nothing to do with perinephritis. The hematoma occurs after the hematoma becomes infected.

DUPLICATION OF RENAL PELVIS AND URETER

UNSUCCESSFUL HEMINEPHRECTOMY

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Case A 387672, Mr. C. F. P., aged twenty-eight years, came to the Mayo Clinic March 29, 1922, complaining of pain in the region of the bladder and right loin and persistent pyuria of seven years' duration. At fourteen, he had had gonorrhea which was mild and apparently cured, as it gave no symptoms for seven years. Onset of the present trouble occurred with chills, fever, vomiting and slight bladder pain. A few days later he noticed pus in the urine and a purulent urethral discharge in the morning. The condition was diagnosed specific urethritis. He was treated without relief by injections, prostatic massage and finally vasotomy with seminal vesicle injection. At the time of his registration at the Clinic he had moderate pyuria, occasional attacks of chills and fever with dull pain referred to the right loin, and urinary frequency.

Rectal examination revealed slight chronic prostatitis. Blood pressure was 118 systolic and 78 diastolic; temperature and pulse were normal. Blood examination showed hemoglobin 77 per cent, with 7200 leukocytes. The urine had a specific gravity of 1.020, a trace of albumin, and 60 pus cells to a field and colon bacilli were found on culture. Prostatic smear and urethral secretion were negative for gonococci. The renal functional test showed a 50 per cent return of phenolsulphonephthalein in two hours. The blood urea was 35 mg. for each 100 cc. of blood, and the Wassermann test on the blood was negative. Roentgen ray of the urinary tract was also negative.

Cystoscopic examination revealed a moderate degree of diffuse cystitis. The left ureteral orifice was normal. On the right of the trigone were two openings less than 1 cm. apart; the median or lower orifice was normal. The lateral orifice was dilated, the



FIG. 1. COMPLETE DUPLICATION OF PELVIS AND URETER

Note close proximity of the two pelves. Moderate dilatation of the lower pelvis.

opening being fully 1 cm. in diameter and turbid urine was exuded from the latter on pressure. Catheters were introduced to a normal length into both ureters on the right. A pyelogram on the right showed two distinct pelves, the upper pelvis normal

in contour although small, with a normal ureter and the lower pelvis and ureter irregularly dilated (fig. 1). A pyelogram on the left showed a similar duplication of the pelvis of the left kidney



FIG. 2. COMPLETE DUPLICATION OF URETER; LOWER PORTION OF URETERS
IN COMMON SHEATH WHICH COULD NOT BE DIVIDED
WITHOUT OPENING EITHER URETER

but the two ureters were anastomosed about 15 cm. above the bladder. On differential functional test with phenolsulphone-phthalein there was a 10 per cent return of the dye in fifteen minutes from the upper pelvis on the right and only a trace from the lower and a 15 per cent combined return in fifteen minutes on the left.

A diagnosis was made of complete duplication of the right renal pelvis and ureter, with infected hydronephrosis and atrophy of the lower segment. Heminephrectomy was considered indicated.

At operation the diagnosis was corroborated. The entire right kidney was smaller than normal and there was no external demarcation of the two segments. The two ureters were intimately related and covered by a common sheath extending for a distance of about 10 cm. above the bladder (fig. 2). As it was impossible to separate them, it was necessary to perform a complete nephro-ureterectomy. After removal, the two ureters were found to be so adherent that it was impossible to separate them without opening into either ureter. On section of the kidney, the two pelvises were found to be so closely adjacent that heminephrectomy would have been very difficult. The ureter leading to the lower pelvis was markedly dilated, the lower third having a maximal diameter of 2 cm. Ligation of the ureter in its upper portion where it is free was not deemed advisable, since the lower portion might act as a diverticulum.

DISCUSSION

This case is of interest in that heminephrectomy was indicated by the localization of infection and comparative function of the two segments, although anatomically this was impossible. The surgical indications for heminephrectomy are: localization of the infection to one segment; marked reduction of function in one segment and normal function in the other; and sufficient distance separating the two pelvises to permit bisection. If ureterectomy is also indicated, it is necessary that the two ureters be independent and not enclosed by a common sheath, as was true in the case reported. It is evident, therefore, that in this case two essential requisites for successful heminephrectomy and ureterectomy were absent.

CYSTOGRAPHY AN AID IN DIAGNOSIS OF CERTAIN UROLOGICAL CONDITIONS¹

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Radiographic and flourescopic examination of the bladder after it has been injected with materials more or less impervious to X-rays, is doubtless a procedure familiar to every member of this society. A glance at the literature on the subject, however, would seem to indicate that this simple procedure which at times shows us so much, is either not generally used or is considered unworthy of report.

Physicians are not infallible and like all human beings are quite apt to overlook simple methods in doing their work, to use something more complicated and at times not nearly so effectual.

With these facts at hand I believe it not amiss to present experiences with cystography in my own work.

Materials in general use for injecting the bladder are: (1) Solutions of 5 to 20 per cent sodium bromide or iodide and 5 to 15 per cent thorium nitrate; (2) emulsions of argyrol, silvol, car-gentos, collargol and silver iodide; (3) gases, such as air and oxygen.

We have found 10 per cent sodium bromide solution the best for all around use, though it does not cast so pronounced a shadow as silver iodide emulsion. Owing to the fact that emulsions precipitate early, everything must be in readiness to make the exposure, or else a deception, due to precipitation, may be registered. Especially is this true of silver iodide emulsions. Air has been used only when making contrast cystograms.

The technique of injection and exposure, while comparatively simple, should be carried out in a definite, systematic manner to

¹ Read before the Chicago Branch of the American Urological Society,

accomplish best results. A sterile soft catheter is passed through the urethra into the bladder and the bladder washed as nearly as possible of all foreign material, with sterile water or boric acid solution. With the patient in a horizontal position, feet and buttocks elevated at an angle of 20 to 30°, the shadow casting



FIG. 1. CONTRACTED BLADDER, HYDROURETER AND PYONEPHROSIS

material to be used is allowed to flow by gravity slowly into the bladder until the patient feels a sensation of fullness. We have found that intravesical enlargement of the prostate can be better demonstrated by only filling the bladder to one-half or two-thirds capacity. The catheter is then withdrawn, corked or

clamped, preferably the latter, and a flourescopic examination may be made or plates exposed as the operator sees fit to do. If plates are used, a preliminary exposure before the bladder is injected usually is of value for comparison.



FIG. 2. LARGE CARCINOMATOUS TUMOR OF BLADDER, MAN AGE TWENTY-FOUR YEARS

Position of the tube in making the exposure is quite important. We have had better results in our work at St. Anthony's Hospital in making simple cystograms by using a cone to produce slight compression; directing the tube under the pubes at an angle of 10 to 15°. If a leaky ureter or hydroureter is suspected the tube

is elevated and exposure made on a plate or film large enough to include bladder, ureters and kidneys.

Contrast cystograms are made by allowing the injected material to escape through the catheter and making an exposure



FIG. 3. COMPLETE RETENTION OF URINE

P, hypertrophied prostate; *D*, diverticulum of bladder

after air or oxygen has been injected. They are of value in demonstrating diverticula and some vesical ulcers. A diverticulum of the anterior or posterior wall of the bladder can occasionally be better shown by making a lateral exposure. Stereoscopic views are also of value in showing these sacculations.

The procedure is properly completed by lowering the patient's feet and buttocks and washing the bladder with sterile water as freely as possible of the injected material to guard against irritation.



FIG. 4. COMPLETE RETENTION OF URINE
P, hypertrophied prostate; *S*, stone in bladder

Time consumed should only be ten to twenty minutes and with proper technique, no shock or inconvenience to the patient should follow the manipulation; except possibly with a few of the debilitated old patients who usually have some reaction from any manipulation in their bladders.

As to practical application, we have found cystography virtually indispensable in ascertaining the size, shape and position of the bladder; the number, size, shape and position of vesical diverticula, and in the diagnosis of hydroureter with incontinence



FIG. 5. COMPLETE RETENTION OF URINE

P, hypertrophied prostate. Both ureters are incompetent and dilated

of its mechanism of closure. We believe it of great value in the diagnosis of calculi in the posterior urethra or prostate, some vesical calculi and those tumors of the bladder of such dimensions that a correct idea of their size, shape and position cannot be ascertained through cystoscopy.

Another class of cases which really is the stimulus for presenting this paper and the lantern slides, which are to follow, includes those patients with prostatic obstruction who are physically and mentally so much below par that any little shock, such as a cystoscopic examination, will throw them off their balance resulting in sepsis, uremia and death. Usually the history, enlargement of the prostate to rectal palpation and demonstrable residual urine are sufficient to make a diagnosis of prostatic hypertrophy. Before operating, however, the average up-to-date urologist should familiarize himself with the amount of intravesical prostatic enlargement, as well as the size, shape and contents of the bladder. The presence or absence of vesical diverticula should also be determined as all of us have probably seen cases where prostatectomy had been performed and the symptoms not relieved because of an existing diverticulum. Another condition often overlooked, but not so important, is ureteral incontinence with dilation.

Cystoscopy is justly the popular method of definitely establishing the fact that intravesical prostatic hypertrophy exists and of examining for the various conditions of the bladder and ureters, which may accompany prostatic obstruction. It is not the aim in this presentation to detract from the merits of cystoscopy in any way, as a safe method of examination in a large percentage of cases with prostatic obstruction. Introduction of so rigid an instrument as the cystoscope through a channel encroached upon by an enlarged prostate and made torturous by the upward projection of the median lobe, would naturally injure the tissues to a more or less degree. Any lesion of these tissues no matter how small invites absorption of infectious material.

Many of these debilitated old patients have already received all of the insults their systems will tolerate. It is this class of cases in which I feel that cystography is preferable to cystoscopy as a safer method of examination and one that gives us equally as much, if not more information.

DISCUSSION

Dr. H. C. BUMPUS, Rochester, Minnesota: We have found cystograms of great aid in the diagnosis of diverticula of the bladder but in a large series of prostate cases we found marked elevations in the bladder without any particular enlargement of the prostate. Further investigation revealed the fact that an accumulation of feces in the rectum gave the same elevations.

I should like to call attention to an erroneous diagnosis that may be made in cases of bladder tumors in which there is a great deal of bleeding. In several of our cases the filling defect was caused quite as much by clots as by the tumor itself. In these two conditions, therefore, we have not found cystography as reliable as it is in cases of diverticula of the bladder.

Dr. MOORE (closing): When preparing a patient for x-ray, which includes the examination of any part of the gastro-intestinal tract, we should always be sure there is no fecal matter present, by first eliminating with cathartics and colonic flushings.

The cystographic findings of these prostate cases, as I mentioned, are taken together with physical findings of prostatic enlargement as determined by palpation and a certain amount of residual urine.

I do not think it would be a good idea to take cystograms of a series of patients and say, from the cystographic findings alone, that this patient has an enlarged prostate and this one has not, without considering other findings with them.

I believe a cystogram is of great value in showing the size of bladder tumors when they are so enlarged we are unable to determine their size through cystoscopy. Blood clots may form in the bladder but we would have other signs of hemorrhage.

Diverticula of the bladder can probably be best shown by stereo-roentgenograms.

THE CHARACTER AND TREATMENT OF BLADDER ULCERS¹

EDWARD L. KEYES, JR.

New York

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The propositions I desire to set before you in reference to chronic inflammatory bladder ulcerations may be briefly summarized as follows:

1. Chronic inflammatory ulcerations of the bladder may be grouped into three classes, viz.: (a) Tuberculous ulcers; (b) ulcers of the so-called Hunner, or elusive type; and (c) incrustated ulcers.

2. The incrustated ulcer is a thing apart, apparently due to a special type of coccic infection, often located on the trigone and about the bladder neck, often clinically and cystoscopically simulating carcinoma, yet often readily curable by local applications of argyrol or of acidophilus or Bulgarian bacillus.

3. The elusive ulcer, occurring in the mobile part of the bladder away from trigone and urethra, is sometimes associated with tuberculosis, sometimes with generalized cystitis and with pyelitis. Indeed it is not yet proven that the submucous lesion is not rather the remnant of an acute generalized cystitis than a specific entity. The clinical history and the location of the ulcers suggest that they begin from mechanical causes, like a crack in a chapped lip, and are perpetuated by the incessant bladder activity set up by their own sensibility, thus making a vicious circle. The submucous infiltrate about them spreads over a wide area and over the whole of this the mucosa readily cracks on stretching. Hence the varying clinical course of the disease; hence the general tendency of the symptoms to grow worse with the lapse of years.

¹ Read at the meeting of the American Association of Genito-Urinary Surgeons, Washington, D. C., May 1, 2, 3, 1922.

4. Hence also the great variety of treatments that succeed in individual cases. The mildest antiseptic irrigations relieve the symptoms of some. Immobilization of the bladder by efficient in-dwelling catheter, with or without continuous irrigation, relieves some. Indeed, resection with suprapubic post-operative drainage surely acts by immobilization when all of the infiltrated area is not cut away. Dilatation of the urethra to 30°F. has relieved two of my cases, doubtless by relieving trifling urethral retention. Cystoscopic cauterization of the ulcers by the silver nitrate pencil, by the high frequency current or by liquor hydrargyri nitratis has relieved others (treated by different men).

5. Resection does not relieve all cases, and many apparent cures by resection are vitiated by relapse. I have cured such relapse by stretching the urethra (which should be tried in every case) and cauterizing the ulcers.

6. Yet operation has a place as the last resort, to get rid of ulcers so chronically infiltrated that no other treatment will heal them. But relapse should be guarded against by careful observation and such local treatment as seems to do the most good.

7. I have no observations relating to the influence of focal infections in the etiology of bladder ulcer. The onset or accentuation of the symptoms of cystitis during or following an acute infection (notably, of late years, the so-called "influenza") is, of course, well known.

8. Tuberculous bladder irritability persisting for years after nephrectomy may be due to a variety of causes among which tuberculosis of the remaining kidney and of the urethra (causing partial retention of urine) are prominent.

9. Moreover the bladder lesion of chronic tuberculous cystitis may be a pure tuberculosis but is more often a mixed infection.

10. Discreet treatment of the bladder may, even in the presence of the tuberculosis of the prostate or of the remaining kidney, marvellously relieve the symptoms.

11. This has been accomplished in the most various ways. One may mention the administration of *ol. santal*; the instilla-

tions of bichlorid, iodoform in oil or carbolic acid; vesiculectomy; relief of urethral retention by the passage of the cystoscope or by the Chetwood operation; cauterization of ulcers or tuberculous granulomata by silver, acid or spark; and finally immobilization by catheter, by suprapubic drainage, by ureterostomy.

12. It would seem, however, that in certain bladders the mixed infection supercedes the tuberculosis in part or even wholly, and the lesions conform to the type of elusive ulcer. Thus Hunner informs me that he has cured two such cases by resection of isolated ulcers in the vault, the resected tissue showing no tuberculosis and I know that he has relieved a case of mine by cauterization and ureter dilatation.

13. My experience with cauterization of tuberculous bladder lesions is as follows: one case unimproved; one case (three years after nephrectomy) intervals increased from one to two or three hours, gained 18 pounds in weight; one case (five years after nephrectomy) intervals increased from incontinence to one hour; one case (seven years after nephrectomy) intervals increased from incontinence to six hours by night, four by day. The relief in this last case has persisted one year, in the other two for six months.

14. It would seem that isolated granulomata of a purely tuberculous type have been healed by the high frequency current. I have cauterized one case (eight years after nephrectomy) once with acid but without appreciable benefit.

URINARY LITHIASIS IN CHILDREN¹

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Minneapolis, Minnesota

Received for publication May 10, 1922

Differences of opinion exist concerning the prevalence of urinary lithiasis in infancy. In this country, few cases have been reported and the text books and journals contain few reports of articles concerning this subject.

A. N. Collins in 1913 reviewed the literature and reported a patient whom he had observed. This is the most complete contribution that has been published in the United States.

OCCURRENCE

Holt, basing his observation on a thousand autopsies, finds calculi common in infants. He writes that stones are frequently voided during the first two years of life. Langenbeck found a calculus in the bladder of a six months fetus. Brendel reports two babies with urinary lithiasis occurring two days after birth. The foreign literature contains many reports of urinary stones in infants. One writer found 47 per cent of a large number of urinary stones occurring in children. Another collected 1836 reports of children with urinary lithiasis. Dr. J. O. Thompson, of the Canton Hospital, found 38 per cent of 586 patients with urinary stone in children under fifteen years of age.

We have collected by means of a letter sent to the members of the American Urological, American Pediatric and the Central States Pediatric Societies, 203 reports of children or infants

¹ Presented before the annual meeting of the Minnesota State Medical Association, Duluth, Minnesota, August, 1921, and the Chicago, Urological Branch of the American Society.

with urinary lithiasis. The average age is seven and eight-tenths years. We have examined and treated 6 patients who are included in this report. Forty of the total number collected occurred in children up to five years of age, 60 in children between five and ten years and 58 between ten and fifteen years. In 45 instances the age was not given. We found 155 males and 45 females (about 3 to 1). In 3, the sex was not specified.

From the data which we obtained by means of this circular letter, we were unable to determine the relative frequency of urinary stones in infants as compared with adults. This condition occurs much more frequently than is generally supposed as many cases are not recognized. It is quite certain that a great many small stones are passed by the infant after a supposed attack of intestinal colic. Unless the urine has been totally arrested for several hours or a day, the mother's or the physician's attention may not be directed to the urinary organs, so that urinary stone is not suspected. Children living in certain localities seem to be more susceptible to stone formation. The nutrition of the infants and children was not considered. The type of food which was given, whether breast fed or not, was not observed. This data is important and will form the basis of a paper which we hope to publish later.

ETIOLOGY

Although infants, children and adults are not subjected to the same degrees of infections and trauma, the same theories may be used to explain the formation of stone. However, it is not possible for us to estimate the number of children who suffered from severe infections nor could we estimate the relation of trauma to stone formation.

One writer is of the opinion that stones are more prevalent in children who have passed through one or more of the severe infections. Kretschmer in a recent paper on "The Treatment of Pyelitis in Infancy and Childhood," found stones present in a number of instances. It is rather difficult, however, to determine which was present first—the stone or the infection. The composition of stones removed was not ascertained. As the

organs of metabolism in the infant and child are more liable to up-sets than those of the adult, it is possible to believe that faulty metabolism together with infection and trauma may be the basis of kidney stone.

The large fluid intake of children and infants, if such fluids contain an excess of salts with peculiar chemical properties, may be a factor in the formation of calculi.

Keyes, in a recent article writes, "Urinary stones consist of non-acicular crystals about a nucleus of organic matter." He also states, "Concentration of the urine in the presence of pus or blood, due to trauma or disease, must be the occasion of stone formation."

LOCALIZATION

The *location* of the urinary stones in the 203 patients which we report is as follows:

Right kidney, 21 patients, or 10 per cent; left kidney, 8 or 3.9 per cent; right ureter, 7 or 3.4 per cent; left ureter, 8 or 3.9 per cent; bladder, 116 or 57 per cent; urethra, 25 or 12 per cent; one kidney and one ureter, 9 or 4 per cent; both kidneys, 14 or 6 per cent; both ureters, 1; both kidneys and ureters, 1.

In this series 69 per cent of stones had passed into the bladder or urethra. We found 10 per cent in the kidneys and 8 per cent in the ureters. The majority of urinary stones in children seem to pass rather easily through the infant ureter and only a small number remain in the kidney. Although important, we did not get information which made it possible for us to determine the number of patients with stone in the kidney cortex as compared with those with stone in the pelvis.

SYMPTOMATOLOGY

Considering the entire urinary tract, we find the following symptoms most common: (1) pain and colic, (2) hematuria, (3) frequency (4) pyuria, (5) dysuria, (6) nausea and vomiting.

Pain was a prominent symptom in 54 per cent of the total number of patients reported. It occurred more often with

kidney stone than with stone found in the bladder, ureter or urethra. We find that 93 per cent of renal stones gave a history of pain, indicating that the great majority of stones found in the kidney were loose in the pelvis. As in the adult, renal stone in the infant may be symptomless. When they are loose in the pelvis and lodge in the uretero-pelvic juncture or in the ureter, pain is pronounced. In very few instances, however, was prolonged, severe pain a prominent symptom.

In this series, we find that only 87 of the patients suffering with *ureteral stone* complained of pain. The infant's ureter must be capable of great distention and complete plugging or obstruction cannot occur as often as it does in the adult. We know of no condition that will universally produce severe pain as will the

TABLE 1

	PAIN	HEMA- TURIA	PYURIA	DYSURIA	FREQUENCY	NAUSEA AND VOMITING
	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>
Renal stone.....	93	57	30	11	30	4
Ureteral stone.....	87	54	20	12	39	10
Bladder stone.....	60	42	48	50	50	0
Urethral stone.....	68	48	28	48	48	0

passage of a stone through the ureter. Frequently, it is necessary to differentiate renal or ureteral pain from intestinal colic. With intestinal colic, the child cries intermittently, while in the presence of ureteral stone, the baby or child may cry for many hours because the pain may be continuous. The sudden cessation in the crying may indicate that the stone has passed into the bladder or has passed through the urethra into the napkin. With ureteral stone, diarrhea is absent. This finding may be positive with intestinal colic.

In Monsseaux's series of 87 patients, *hematuria* was present in only 8. It is infrequent that an urinalysis is made in infants suffering with abdominal pain (52 per cent in this series) so that the finding of gross blood is more often reported than the finding of microscopic blood. It is our opinion that an urinalysis of every patient would reveal blood in a larger number than we were

able to report. Gross blood in the urine does not seem to be diagnostic of the location of the stone, as in this series this finding was of approximately equal frequency. With kidney stone, blood was reported in 57 per cent; with bladder stone 42 per cent; with ureteral stone 54 per cent and urethral stone 48 per cent.

Pyuria was reported in 48 per cent of bladder stones and in 30 per cent of the renal stones. This is a report of macroscopic findings and does not indicate the findings after a microscopic examination. We are of the opinion that kidney stone will produce pus in the urine much more often than bladder stone. Because of the infrequency of an urinalysis, it is impossible to determine the relative frequency of pyuria.

Dysuria. With bladder and urethral stone, dysuria was reported in 50 per cent of the cases. With ureteral stone, this symptom was noted in 12 per cent and with renal stone 11 per cent.

Anuria. Anuria may occur when a stone is lodged in the urethra. This symptom in a great many cases has called the mother's or the physician's attention to the urinary tract. When children have not passed urine for several hours or days, the introduction of an urethral catheter may be impossible because of obstruction in the urethra caused by a stone. In many instances, a diagnosis had not been made until catheterization had been attempted.

Frequency of urination, as would be expected, was reported more often with bladder and urethral stones (50 and 48 per cent) than was found with renal or ureteral stones (30 and 39 per cent).

Nausea and vomiting, which is a very indefinite symptom, when one is considering children or infants, was reported in 10 per cent with ureteral stones, and 4 per cent with renal stones. With bladder and urethral stones, nausea and vomiting was not noted.

Kidney enlargement or the formation of a *tumor*, was a very inconstant finding. We were unable to estimate the number of patients with tumor.

DIAGNOSIS

In the young infant, the diagnosis may be difficult. Sudden, prolonged, abdominal *pain*, most frequently without warning, without diarrhea and with or without gross hematuria in an infant who has had no previous gastro-intestinal upset, should make one suspicious of renal or ureteral stone. With bladder or urethral stone, continuous, frequent and painful urination with blood in the urine is found in the majority of patients. The *location* and *radiation* of the *pain* may be helpful but cannot be relied upon. The presence of *tumor*, which is rare, may assist in the diagnosis. Tenderness may be elicited over the affected side.

The roentgen ray will assist in the diagnosis and should always be used. In 112 instances of 203 reports, stones were discovered by the roentgen ray. Tiny stones may be missed but the majority will make a shadow on the plate or film. The finding of bits of gravel in the urine or urethra clinches the diagnosis. *Urinalysis* is usually difficult and may be negative but should be made as the finding of blood or pus assists in the diagnosis.

Cystoscopy, although difficult, can be done in very young children. Girl babies of six months have been cystoscoped with the separation of the urine. We have successfully cystoscoped and catheterized boys of five and six years of age. We have used chloral hydrate (20 grains in solution) as a rectal injection for anesthesia in babies. The infant will remain quiet and suffers little pain. Cystoscopy should not be done until the infant is sound asleep, which may require thirty to forty-five minutes. A double pyelogram was done on a boy of eight. In boys a small instrument with a small beak can be used with little trouble. Great care should be exercised as the urethra is easily torn and when such an accident occurs, a stricture will usually follow. It is advisable to split the meatus which will greatly assist in the safe passage of the instrument into the bladder. Cystoscopy should be done whenever possible together with the catheterization of the ureters. Sixty-seven of the 203 patients whom we have collected were cystoscoped. We have repeatedly

noticed the large calibre of the infant's ureter when compared with the bladder and the urethra. The largest catheters can be passed with ease. This observation has been made in the normal infant, as well as in those having stone or infection.

Diagnoses were made by *clinical findings* alone in 22 cases. *Rectal examination* should never be overlooked. The ureteral stone found in one of our patients was easily palpated per rectum.

TREATMENT

Early surgical removal should be practised, when the stone does not progress or when it is producing damage to kidney.

TABLE 2

CYSTOTOMIES	URETEROTOMIES	PYELOTOMIES	NEPHROTOMIES
77 suprapubic 4 perineal	5 primary 1 (preceding nephrectomy) 1 bilateral	8 primary 1 bilateral	6 primary 2 bilateral 1 (preceding nephrectomy)
NEPHRECTOMIES	NEPHROPYELOTOMIES	MEATOTOMIES	URETHROTOMIES
4 primary 1 (following ureterotomy) 1 (following nephrotomy)	1 primary 3 bilateral 32 cases of manipulation or crushing through cystoscope, etc.	11 primary	2 primary

When patients are too small to permit of cystoscopy and ureteral catheterization together with functional tests, exploration should be done to determine the presence of both kidneys. Bilateral lithiasis, especially when the stones are small, multiple and in the cortex of the kidneys, should be treated expectantly. The removal of kidney stones does not remove the cause of their formation so that the amount of destruction necessary to remove them should be weighed against the destruction being caused by them and the probability of the stones finding their way into the

pelvis and passing through the ureter. In this series, 69 per cent of kidney stones passed to the bladder.²

One hundred and fifty-five patients or 76 per cent were operated upon. Only 33 per cent of patients in this series were cystoscoped. Fifty-five per cent were examined with the roentgen ray. It is our opinion that if cystoscopy and roentgen ray examinations had been done routinely, that operation would not have been necessary in so large a number. In three, the stones passed per urethram and affected a cure. In 9, the stones were probably passed, although they were not recovered. In 10, treatment was refused. In 24 instances there was no report as to treatment.

Cystotomy or cystoscopic removal can be done with much less trauma to the patient than an open operation. In this series, we find that 78 per cent of operations which were done for the removal of urinary stone, were cystotomies, urethrotomies or some type of manipulation or cystoscopic removal.

PROGNOSIS

A large number of the reported cases of lithiasis in infancy and childhood were discovered at autopsy. In only 2 of our patients diagnoses were made at autopsy. Collins reported that 43 per cent of the patients with urinary stones he collected, were discovered post mortem. Ninety-two per cent of these under five years of age occurred before the second year, indicating a high early mortality. One of our patients had multiple stones at nine years of age. One of the stones was more than 2 cm. in its longest diameter so that it was present some time before it was discovered. Kidney stones can be present for years without materially affecting the function of the kidney. After infection takes place, the kidney may be quickly destroyed. Bilateral involvement is very frequent. American and foreign authors report 65 per cent and 50 per cent. In our series, bilateral

² We assuming that all urinary stones found in the bladder except in the presence of urethral obstruction, bladder deformity or spinal cord lesion, originate in the kidney.

stones were found in 33 per cent. Early diagnosis, together with proper treatment before kidney destruction takes place, will save many kidneys and possibly a few lives.

The results of treatment are as follows: 101 or 54 per cent were reported cured; 95 or 47 per cent were not reported; 5 or 2.5 per cent had recurrence of symptoms, and 2 died.

Mortality. There was an operative mortality in this series of 0.6 per cent. We are unable, however, to trace many of the patients reported over long periods of time.

CONCLUSIONS

1. Urinary lithiasis is frequent in childhood and infancy, the average occurrence in the three large series reported being 43 per cent; average age is seven and eight-tenths years. The youngest patient in this series was ten months old.

2. We are unable to determine the etiology of urinary stones in infants, although in our opinion infection is one of the factors.

3. Twenty-one per cent of our cases involved the kidneys or ureters. The comparison of right kidney to left is 21 to 8. Only 8 per cent were arrested in the ureter.

4. Assuming that the majority of urinary stones in infants (except in the presence of urethral obstruction or malformation) originate in the kidney, 69 per cent will pass as far as the bladder.

5. The symptomatology in the order of occurrence is as follows: (1) pain and colic, (2) hematuria, (3) frequency, (4) pyuria, (5) dysuria, (6) nausea and vomiting.

6. The infant ureter is capable of great distention or in some other manner facilitates the easy passage of ureteral stone.

7. Diagnosis depends upon the following positive findings: (1) x-ray (112 in 203 cases), (2) cystoscopy (33 per cent), (3) urinalysis (52 per cent), (4) clinical findings alone (11 per cent).

8. Surgery is indicated when stones do not progress through the urinary tract. Seventy-eight per cent of the operations were done upon the bladder and urethra. When renal stones are bilateral, surgery should be carefully considered.

9. The prognosis is unusually good. In this series, there were 2 deaths, one with bilateral stones, the other occurring in con-

junction with urinary malformation; 50 per cent were reported cured; 2.5 per cent had recurrence of symptoms and 47 per cent were not reported.

10. Urinary stone in children may remain symptomless for many years. One of our patients had ureteral and bladder stones for eight years with slight symptoms.

11. Stones discovered during adult life may have their beginning during childhood or infancy.

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DISCUSSION

DR. HENRY L. SANFORD, Cleveland, Ohio: I would like to ask Dr. Thomas what size cystoscope he uses on these small children, say, from five to eight years of age. Do you use a single barrel catheterizing cystoscope, and put in one catheter and then pull the cystoscope out, and then put in another catheter, and so on.

Dr. THOMAS: It is no. 9 French.

Dr. SANFORD: No. 9 French is the size of the ureteral catheter.

Dr. THOMAS: You can have them made to take a no. 6 catheter, but a child will take a no. 7 without the least difficulty.

Dr. EDWIN DAVIS, Omaha, Nebraska: I would like to ask Dr. Thomas whether in this series of cases of urinary lithiasis in children he got any evidence of urethral obstruction; whether they had residual urine, and whether there was a history of recurrence of bladder calculi after operative interference.

Dr. H. C. BUMPUS, Rochester, Minn.: Some interesting work has been done recently at the Mayo Clinic relative to the etiology of renal calculi. In a series of experiments by Dr. Meisser and myself to determine the cause of pyelonephritis an organism was recovered which when injected into rabbits showed marked elective affinity for the kidneys. A vaccine was made from this strain of bacteria with the idea of producing an immune serum. This was injected bi-weekly into a sheep intravenously, and at necropsy the kidney of the sheep was found to be filled with small calculi. Since then dogs have been used, and instead of injecting the vaccine repeatedly intravenously, live bacteria have been placed in devitalized teeth, and in several months renal calculi appeared.

Dr. THOMAS (closing): Dr. Davis asked about urethral obstruction in association with recurrence of stone. In addition to the children which were reported in the paper which I just read, I have observed 6 others—making a total of 12. Among this number I discovered one or two instances wherein there was recurrence of bladder stone. As I remember both children had some obstruction to the urethra which was thought to be congenital. In other instances, in which there was recurrence of bladder stone, we are unable to get a previous history of renal colic but the urethra was not carefully examined so I cannot say that there was or was not obstruction.

COINCIDENT CALCULUS AND DIVERTICULUM OF THE BLADDER¹

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It is not our purpose to discuss the much argued question of whether diverticula of the bladder are congenital or acquired, but to direct attention to the importance of diverticula in some cases as a factor in the formation of stone in the bladder. Recently a study was made of 609 patients with stone in the bladder who were examined or treated in the Mayo Clinic between the years 1907 and 1920 inclusive. During the same period there were 222 who had diverticula of the bladder of such size or shape as to make them of importance pathologically. Twenty-eight of these 222 patients (12.1 per cent) had diverticula and bladder stone. These diverticula did not include the small open-mouthed depressions commonly known as "cellules" which are found in most retention bladders. They varied in size from 2 or 3 cm. in diameter to large sacs holding many ounces, and in some instances they were larger than the bladder itself. The lateral walls and base were the most frequent areas of communication with the cavity of the bladder, although a few were found in which the opening was in the posterior wall or dome of the bladder. The incidence in women or young men was small, the majority occurring in men who were fifty years of age or more.

Pathology

Before infection takes place diverticula consist of thin-walled sacs which may be lined with bladder mucosa or, as reported by Hinman, the mucosa may be entirely absent, the outer coats being greatly stretched bladder musculature, usually without any

¹ Presented before the Surgical Section of the West Virginia Medical Society at Charleston, May 26, 1921.

continuous well-defined muscle layers. At this stage they are but slightly attached to the perivesical tissues and often can be invaginated into the bladder. The stretching of the sac wall renders the musculature more or less atonic, and the atony as well as the fact that the mouth of the diverticulum is usually relatively small and located in the upper portion of the sac, favor retention of urine, although the main cavity of the bladder may empty completely. Retention in the sac soon leads to infection, with the result that the previously thin wall becomes greatly thickened with inflammatory infiltration, is friable, sometimes necrotic, and densely adherent to all surrounding tissues. The constant overflow of infected urine into the bladder produces a cystitis which may be of such severity that a satisfactory cystoscopy cannot be performed and the mouth of the diverticulum can be overlooked easily.

Formation of stone in the urinary tract is usually attributable to two known predisposing causes, retention and a nucleus for the deposit of urinary salts. Since both of these conditions exist for long periods without the formation of stone it seems to be evident that there are other factors that have not been proved definitely. It is readily understandable, however, that diverticulum of the bladder, with retention, infection and nuclei in the shape of blood clots, desquamated epithelium, pus, necrotic tissue, and so forth, is a fertile field for the formation of stone. The stone may remain in the diverticulum or it may migrate into the main cavity of the bladder.

Symptoms

The symptoms of diverticulum of the bladder and of stone in a diverticulum are alike and essentially those of the coexisting vesical infection, such as frequency, pain and pyuria, so that a differential diagnosis cannot always be made without the aid of cystoscopy and the roentgen ray. A diverticulum can always be diagnosed if the possibility of its existence is recognized by the examiner, but since the coexisting cystitis, stone in the bladder, or hypertrophy of the prostate are often alone sufficient to account for the symptoms, the possibility of a diverticulum is often

overlooked and the further necessary examinations are not made. It has been definitely shown also that a diverticulum can easily be overlooked by a competent surgeon performing a suprapubic cystostomy. There are several conditions, however, that should indicate the possibility of a diverticulum and lead to the examinations necessary for a positive diagnosis.

1. Hemorrhage from the bladder without other assignable cause, the hemorrhage being more profuse than is usual with cystitis or stone and probably the result of severe infection and stretching of the sac walls.

2. A marked slowness in emptying the bladder, the urine coming in a dribble, in the absence of an enlarged prostate, stricture, or lesion of the spinal cord. This symptom is found chiefly with diverticula of large capacity and easily dilatable walls, when the force of the bladder is directed along the line of least resistance into the diverticulum rather than into the urethra.

3. A very low phenolsulphonephthalein or indigocarmin output from a catheterized bladder, coincident with a normal or nearly normal blood urea, since a portion of the dye may be retained in a diverticulum.

4. Persistent infection or the reformation of stones in the bladder without assignable cause.

5. Shadows in the roentgenograms suggestive of stone in the bladder when stones are not demonstrable on cystoscopic examination.

DIAGNOSIS

Often the diagnosis of diverticulum of the bladder may be made by cystoscopic examination, the mouth of the sac being observed on the bladder wall. Sometimes stones in the diverticulum may be seen protruding through into the cavity of the bladder, usually surrounded by an inflammatory area and granulation tissue. The cystoscopist can sometimes see where the nucleus of a stone, free in the bladder, has broken off from the stone projecting from a diverticulum. If the opening can be seen through the cystoscope a fair idea of its size and location is obtained by coiling a roentgenographic ureteral catheter in the sac and making

a roentgenogram. In many cases, however, severe cystitis, obstructing prostate, or other cause prevents a satisfactory cystoscopic examination; in these cases a cystogram will usually give the data required.



FIG. 1. (CASE A320659.) LEAD CATHETER COILED IN DIVERTICULUM. DIVERTICULUM AND BLADDER PARTIALLY FILLED

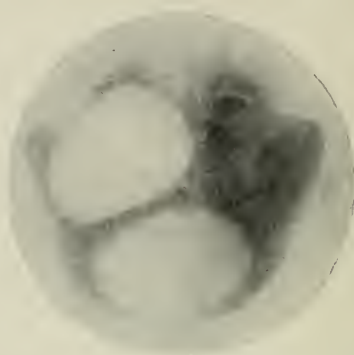


FIG. 2. (CASE A320659.) DIVERTICULUM AND BLADDER COMPLETELY FILLED. CYSTOGRAM

TECHNIC

A roentgenogram is made of the vesical area; the bladder is then emptied completely with a soft rubber catheter, and the bladder filled comfortably full through the catheter with an



FIG. 3. (CASE A249315.) LEAD CATHETERS COILED IN TWO DIVERTICULA OF THE BLADDER



FIG. 4. (CASE A249315.) BLADDER AND ONE DIVERTICULUM SHOWN IN CYSTOGRAM

emulsion of silver iodid, 2.5 to 5 per cent, or other non-irritating roentgenographic medium. The catheter is then removed and the patient tipped into a semi-Trendelenberg position. Several plates are made of the bladder at different angles, so that if a diverticulum is present the shadow will not be projected on the shadow of the full bladder in all the plates. The patient then voids, or if there is retention he is catheterized, and another roentgenogram is made which should show the outline of the diverticulum, the amount of retention in it, and whether or not shadows suspicious of stone are included in the diverticulum. With this technic a positive diagnosis can be made in almost every case. If there is a question of whether the shadows are in the ureter or in the diverticulum, the ureters can, of course, be excluded by means of lead catheters or a ureterogram.

TREATMENT

The removal of a stone from the bladder when a diverticulum is present, or of a stone from a diverticulum, is not sufficient, since, if the original source of the stone remains, a recurrence is to be expected. The diverticulum may be removed at the same time the stone is removed, or as a secondary procedure. The same preoperative preparation should be employed as for prostatectomy, namely, removing the retained urine, clearing up infection, and building up the general health. In cases of large, foul diverticula it is often necessary to obtain drainage by suprapubic cystostomy and by tubes fastened into the diverticulum and into the bladder. A suprapubic excision of the sac and suture of the wall of the bladder are usually indicated. Whether this can be accomplished from the bladder side by invaginating the diverticulum into the bladder after the manner of Young, or whether the sac must be dissected free from the outside and the pocket it occupied drained, depends largely on the amount of infection and adhesions. Judd has pointed out that care must be taken in dissecting in order to avoid the ureter and vas which are often involved in the adhesions. It may be necessary to transplant the ureter into another portion of the bladder. The extravescical dissection is facilitated by a finger in the diverticulum (Judd),

by distending the diverticulum with gauze (Lower), or by a rubber bag (Lerche). In the occasional case in which the diverticulum is shallow and the orifice small sufficient drainage can be



FIG. 5. (CASE A344259.) ONE DIVERTICULUM FILLED AND THE BLADDER NEARLY EMPTY



FIG. 6. (CASE A344259.) THE DIVERTICULUM AND THE BLADDER FILLED

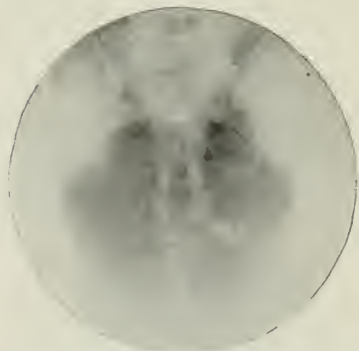


FIG. 7. (CASE A252495.) ROENTGENOGRAMS OF THREE STONES IN THE BLADDER AREA



FIG. 8. (CASE A252495.) TWO LARGE DIVERTICULA FILLED, THE BLADDER EMPTY

The shadows of the stones are obliterated by the shadow of the diverticulum.

obtained by enlarging the opening by a plastic operation or by fulguration through a cystoscope. The bladder in most cases is thick walled, with foul or even gangrenous cystitis.

MAYO CLINIC SERIES

The cases in this series are divided into three groups: Group 1, stone in the bladder without stone in the diverticulum, 13 cases; group 2, stone in both the diverticulum and the bladder, 9 cases; and group 3, stone in the diverticulum alone, 6 cases. The total is 28, 12.1 per cent of the 222 cases of diverticula.

In 15 cases the stones in the bladder were single, in 7 they were multiple; 20 was the greatest number reported in any one case. The stones were reported to be large in 9 cases. Stones in the diverticulum were single in 11 cases and multiple in 4; with two exceptions they were of medium size.

In 3 cases the stone was wedged into the diverticulum with a portion projecting into the bladder. In a review of the literature only 3 cases of this type of dumb-bell stone filling a diverticulum and projecting into the bladder were found. One case was reported by Davis, one by Young, and one, observed in the Mayo Clinic, was reported by Martin. The two new cases included in this report make a total of five cases.

Benign prostatic hypertrophy was noted in 11 patients, stricture was noted in 5, and atonic bladder in 2. Residual urine was found in amounts varying from $\frac{1}{2}$ ounce to complete retention in 12 patients. Twenty-seven patients had more severe cystitis than is uniformly found in uncomplicated cases of stone in the bladder. The walls of the bladder were often thickened and infiltrated throughout and sometimes the mucosa was necrotic. Carcinoma was present in 3 patients, or 10.7 per cent; in 1 the malignant growth was near the mouth of the diverticulum and apparently in 1 it had originated in the diverticulum. Two patients had a duplication of both ureters; this was the only congenital anomaly noted.

The smallest diverticulum was 2 cm. and the largest 9 cm. in diameter. Twenty-one patients had single diverticula; 2 had two each, and 5 had multiple diverticula. One diverticulum was multilocular. The orifices of the diverticula were often recorded as "very small;" they opened into the base of the bladder in 11; in the lateral walls in 10; in the posterior wall in 2; and in the dome in 2; the area was not recorded in 6.

The inflammation in the diverticulum was often of greater severity than in the bladder itself.

Twenty-seven of the 28 patients were males. The one woman in the series had a diverticulum of the base of the bladder, which was probably the result of an operation for the closure of a vesicovaginal fistula.

That diverticulum is an etiologic factor in the formation of stone in the bladder is strongly suggested by the fact that of the 28 patients, 3 had passed many stones before coming to the clinic; 6 had had stones removed at previous operations, 1 having had two operations. In the cases in which the diverticulum was not removed at the first operation in the clinic there have been 7 recurrences in 4 patients, 5 in the bladder and 2 in the diverticulum. The total recurrences, therefore, were 17 in 13 patients. In cases in which the diverticulum was removed there were no recurrences of bladder stone. The high incidence of stone in these cases of 12.1 per cent is also suggestive of diverticulum as an etiologic factor.

Two patients with stones in the diverticula had had previous suprapubic cystostomy and the stones were not found. In one of these patients the stone was completely sealed over in the diverticulum with inflammatory tissue and was diagnosed inoperable carcinoma; he had worn a suprapubic catheter for seven years and a large stone had formed in the bladder.

Treatment

Of the 22 patients with stones in the bladder suprapubic lithotomy was performed on 17, and litholapaxy on 4; one died from a perinephritic abscess and sepsis without removal of the stone.

Eleven of the 15 patients with stones in the diverticula underwent suprapubic operation; in 1 patient the stone was pushed into the bladder and litholapaxy performed; in 1 the stone in the bladder was removed and the patient died from carcinoma of the bladder; in 1 suprapubic drainage only was done because of the extremely serious general condition of the patient complicated

with gangrenous cystitis: in 1 operative procedures were not undertaken; the patient died from carcinoma of the larynx.

In 7 cases the diverticula were excised; in 1 case two diverticula were excised. In 6 the diverticula were excised at the time the stone was removed, and in 1 at a later operation. In 1 case the diverticulum was opened into the prostatic urethra; in 20 the diverticula were not removed. (One diverticulum was removed later elsewhere.)



FIG. 9. (CASE A157750.) ROENTGENOGRAM OF LARGE DUMB-BELL STONE FILLING A DIVERTICULUM AND PROJECTING INTO THE BLADDER

In 5 cases recurring bladder stones were removed by litholapaxy.

In the 3 cases with combined bladder and diverticulum stone (dumb-bell) 1 had a suprapubic removal of a huge stone and diverticulum (Martin). The 2 remaining cases had previously had stones removed from the bladder in the Mayo Clinic; small diverticula of the base had been noted but they did not then contain stones and were not removed. Both patients returned with a stone free in the bladder and a stone filling the diverticu-

lum and projecting through a small orifice into the bladder. Through the cystoscope roughened areas could be seen on the stone in the bladder where it had broken off from the stone in the diverticulum. In 1 the stones were removed from the bladder and diverticulum and the diverticulum excised through a suprapubic incision. In the remaining case the stone was not removed from the diverticulum as the patient was seventy-eight years old and in feeble health. He obtained symptomatic relief when the portion of stone which projected into the bladder from the



FIG. 10. (CASE A157750.) STONE SHOWN IN THE ROENTGENOGRAM IN FIGURE 9, AFTER REMOVAL FROM THE BLADDER

diverticulum was removed with a specimen-taker through the cystoscope and the bladder stone removed by litholapaxy. The fragment removed was pure calcium carbonate. This patient returned later with a third bladder stone which was removed by litholapaxy and the orifice of the diverticulum widened by fulguration. Two years elapsed between each recurrence.²

² Since this paper was read the last mentioned patient has returned to the Clinic with severe cystitis and the stone which was formerly fixed in the diverticulum free in the bladder. The stone was removed and the diverticulum was observed to be wide open as a result of the fulguration. This patient returned again three months later in good health and without cystitis or recurring stone.

MORTALITY

There were 4 deaths (14.2 per cent of 28). One patient died the seventy-second day after suprapubic removal of stones from the bladder and resection of a carcinoma at the mouth of the diverticulum. Death resulted from extension of the carcinoma. One patient died the seventeenth day after a suprapubic drainage for gangrenous cystitis; death was the result of renal insufficiency and sepsis. Two patients died without operation, 1 from carcinoma of the larynx and 1 from perinephritic abscess and sepsis. There was no mortality following the removal of diverticula or of stones from diverticula.

CONCLUSIONS

Diverticula of the bladder occur more frequently than is usually supposed and may often contain stones.

The incidence of primary and recurring stone in the bladder seems higher than when there are no diverticula.

Diverticula are often overlooked both on examination and at operation. They may be easily diagnosed by means of the cystogram.

We should not be satisfied to remove a stone from the bladder, but should if possible correct the cause of its formation and thus prevent recurrence.

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A REPORT FOLLOWING THE USE OF MERCUROSAL IN THE TREATMENT OF ONE HUNDRED AND FIFTY CASES OF SYPHILIS¹

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In a communication to the Wayne County Medical Society (1) we made a preliminary report on the study of the action of a new mercurial in the treatment of 60 cases of syphilis. Since that time we have more than doubled our cases and now wish to present our more mature conclusions based upon our series of 150 cases.

The preparation of choice for internal mercurialization in the treatment of syphilis has long been a subject of divided opinion and discussion. In our search for a practical as well as efficient preparation, we were requested by the Department of Experimental Medicine of Parke, Davis and Company to try mercurosal, a new mercurial prepared by them, and herewith describe our experience with it in the treatment of a series of 150 cases of syphilis. In comparison with other preparations which we have previously used, mercurosal seems to us to be a step toward the future which will some day give us an intravenous mercurial that will become as popular and universal as arsphenamine is today.

Mercurosal is a white soluble powder and chemically is described by its manufacturer as a synthetic derived from mercuric acetate and salicyl acetic acid. Its chemical description is disodium-mercuri-salicyl-acetate. By weight it contains about 44 per cent metallic mercury. Mercurosal is freely soluble in water, giving a slightly alkaline solution which is permanent provided it be protected from the light.

¹ Read at meeting of Chicago Branch of American Urological Society, February 24, 1922.

The solution does not show any of the chemical reactions of mercury in its ordinary salt form, and when mixed with blood serum no precipitate occurs.

The average dose of mercurosal is 1 decigram, supplied in brown glass tubes to be dissolved in 5 cc. of distilled water, making a very suitable solution for intravenous use. While we have not used doses larger than 1 decigram, it is quite possible that heavier dosage may produce a systemic reaction similar to that sometimes following the administration of salvarsan.

The technique of administration is the same as for any other intravenous preparation. A fine point small needle, preferably a 1-inch, 24 or 25 gauge, platinum or steel needle serves admirably. Larger needles cause more pain, more local reaction and are more difficult to introduce. When sixteen or more mercury injections are to be given within a short time it is desirable to preserve the vein outline and lessen the local reaction as much as possible.

The method which we employed in this series was to administer 1 decigram of mercurosal every second day and in no case was it necessary to stop or lengthen the interval between injections because of local or systemic reaction. No local reaction is noticeable and if one has difficulty in injecting a small vein that is hard to locate, with the result that a few drops are injected into the wall or outside the vein, the pain and burning that follow as the result of this error in technique are of short duration and not nearly as intense as in the case of arsphenamine.

Noticeable systemic reactions were present in but 3 cases, the complaint being slight gastro-intestinal irritation, headache and moderate diarrhea.

The absence of the common lesion of skin and mucous membrane was also noted in the 150 cases treated which were all of the secondary type.

Salivation, spongy gums and sore teeth were entirely absent and next to the local reaction itself this condition was the second biggest factor as a cause for discontinuing insoluble intramuscular injections previously used.

The intravenous use of bichloride of mercury, as reported by "Barton," is sometimes attended by localized thrombosis and the dangerous accompaniment of embolism, but in no case in this series was this present.

The patient's attitude is of some moment and this was particularly true of women who did not object to reporting regularly for intravenous medication, but would complain and object to the soreness and pain resulting from the use of insoluble mercurials by the intramuscular route. This sometimes resulted in an attempted cure with arsphenamine alone or the course materially shortened with the patient passing out of control.

In the mercurosal series the advantages particularly noted were that relatively larger doses of mercury could be administered, absence of objectionable local or systemic reaction and, owing to its low toxicity (reported as being $\frac{1}{7}$ that of bichloride of mercury), mercurosal could be given every other day with entire safety. In cases presenting an initial lesion, where intensive abortive measures are required, we find that quicker results in treatment are obtained. A more accurate grading of dosage is made possible and more frequent opportunity is given for observing individual cases. The delayed and uneven absorption of mercury following intramuscular injections and the uncertainty of the amount of mercury absorbed inunction or by inhalation seems to us to be largely overcome by the intravenous use of either bichloride or mercurosal. This was nicely demonstrated by Cole, Tiltmann and Sollmann (2). Mercuric salicylate, probably the most popular insoluble preparation, required an average of four days for complete absorption and the other extreme, gray oil, required forty-three days on the average.

What spirocheticidal action mercury is claimed to possess is seemingly enforced by being thrown directly into the blood stream, simulating the rapid action resulting from arsphenamine. Another instance of being a better adjuvant to the base!

The effect, if any, of mercury upon the kidneys is, of course, a point of importance. So much doubt, lack of definite information or evidence of plain guessing is found in the literature that we made a special point of attempting to clear up any misgivings as to the effect of mercurosal on the urinary apparatus.

Routine urine examinations were made in all cases of the series and considering the urine per se, no evidence of renal irritation was found. Accurate tabulations of solids, water, specific gravity, reactions and macroscopic appearance showed no deviation from the mean daily averages of *normal* individuals used as controls.

Due allowances were also made for physiological variations. The urinary output was especially watched at the end of each individual course, fearing cumulative action of the metal, but selected as well as twenty-four-hour specimens were in entire accord with analyses made when the patient was first admitted.

The clinical observations are practically duplicated by some careful work on laboratory animals to which mercurosol was given. Space will not permit of a complete description of these experiments. We must therefore offer a brief summary of the elimination experiments with mercurosol on dogs.

To a series of dogs mercurosol to a total of about 50 mgm. was injected every two days. These dogs were kept in special cages so constructed that the urine could be readily obtained and studied.

Chemical analyses of the urine showed that using a test in which as low an amount of mercury as 0.5 mgm. would react yet the tests were for the most part only faintly positive, indicating that only a small part of the mercury injected was eliminated by the kidneys. A number of the dogs were internally treated with doses of mercurosol amounting to $\frac{1}{5}$ of the minimum lethal dose and received this amount every other day for a period of ten days and then every day for five days. It can therefore be realized that the treatment these animals received was much more severe than any syphilitic patient would ever be called upon to bear. There was no appreciable effect upon the vein at the site of injection and no noticeable effect upon the general health of the animals while the injections were being made nor during the two months period of observation which followed the completion of the treatment. At the conclusion of the period of observation the animals were destroyed and careful autopsies performed followed by a histologic examination of the kidneys and other organs, all of which were found to be practically normal.

Our clinical experience as well as this laboratory work therefore do not permit of agreement with Hadjopoulos (3) who says that "the elimination of mercurosal is mainly through the kidneys; practically 90 per cent being eliminated within the first twenty-four hours and is complete in three days."

Nor does his statement agree with the experiments of Riederer (4), who gave a dog in thirty-one days 2.789 grams of mercury salt; he recovered 2.2 grams of mercury sulphide, of which 95 per cent, or 2.1175 grams, was in the feces; in the urine 0.055 gram; in the brain, heart, lungs, spleen, pancreas, kidneys, scrotum and penis 0.009 gram; in the liver 0.014 gram; in the muscles 0.0114 gram.

In determining the amount of mercury sulphide eliminated there is some liability to error for it is a well known fact that traces of mercury are commonly found in the stomach, intestines, liver, kidney and other organs of the cadaver with no history of recent administration of mercury. Admitting that the gross and histologic picture of the kidney can only be determined on the necropsy table, we feel from the clinical evidence alone that this new mercury salt can be safely administered without fearing any pathology of the genito-urinary tract.

The soluble mercurials, like bichloride, oxycyanide and mercurosal, which are intended for intravenous use, are probably changed in the circulation to an oxyalbuminate and excreted as mercury sulphide. The mercuric ion forms salts of a higher solubility than the mercurous salt. Considered relatively as a factor causing renal irritation, intravenous preparations of mercury in physiologic doses are much less toxic than either lead or alcohol. The rôle played by the kidney in the elimination of mercury salts is a very small part of the component excretory avenues of escape.

A careful review of the blood Wassermanns done in all the cases of this series showed no pronounced evidence that this form of mercury influenced our results any more rapidly or permanently than other forms used in the past. However, it is difficult to draw definite conclusions from the blood tests alone in cases treated by this combination as the arsenic must receive due con-

sideration in our interpretations. An ideal method for observing the true value of this drug on the blood and on the clinical symptoms would be to use it alone, but for obvious reasons this is difficult in private practice since the patient is pleading for a rapid disappearance of all objective symptoms and the physician's duty is to obtain results as quickly as possible. Our most successful results in obtaining negative blood findings were in the cases which were diagnosed early and treated promptly and intensely with six full doses of arsenic and from twelve to twenty-four doses of 0.1 gram of mercurosal given in the vein.

One of the great advantages of mercurosal is its low toxicity as compared to other mercurials, such as bichloride. Repeated tests on dogs indicate that the minimum lethal dose of mercurosal, when given intravenously, is approximately 0.025 gram per kilo body weight. Control experiments with mercury bichloride showed that the m.l.d. of this salt, given intravenously to dogs, is approximately 0.005 gram per kilo gram body weight, which means that mercury chloride is five times as toxic to dogs under the same conditions as mercurosal.

The same experiments repeated with guinea pigs shows that the m.l.d. of mercurosal is approximately 0.025 gram per kilo gram body weight, whereas mercury chloride under the same conditions shows an m.l.d. of 0.0025 gram per kilo gram; in other words, mercury chloride is ten times as toxic as guinea pigs as mercurosal under the same conditions.

These experiments indicate that the m.l.d. of mercurosal for a 150-pound man would be 1.7 gram. Bichloride under the same conditions would be 0.34 gram. In other words, it would require five times as much mercurosal to kill as would be needed in the case of bichloride. As the average dose of mercurosal is 0.1 gram intravenously, or 0.05 gram intramuscularly, the safety or relative toxicity of mercurosal is assured since the m.l.d. for man is ten to twenty times the therapeutic dose. This is proved by our clinical tests since we have no reports of systemic reactions of any consequence following the injection of mercurosal into human beings. As previously mentioned, there were only 3 of our 150 patients who displayed a noticeable systemic reaction following the dose of mercurosal.

One investigator, Hadjopoulos (3), stated that intravenous injections of mercurosal had occasionally given rather aggravated systemic reactions approaching the symptoms of shock. It was his belief that the reason was due to some interaction of ethyl alcohol and mercurosal and that ethyl alcohol should not be used in preparing the site of injection nor for sterilizing syringes or needles. This did not appear to be a rational explanation nor a needed precaution since alcohol is used in certain parts of the manufacturing process and, as is well known, it is common practice for physicians to prepare the site of an injection by scrubbing with soap and water and finally with grain (ethyl) alcohol, and if the explanation of the reactions was correct, there should be a far greater incidence of such reactions than is actually the case.

To clear this up we enlisted the coöperation of a competent research chemist who conducted the following experiments:

A quantity of mercurosal was divided into two parts, one of which was set aside as a "control." The other part was subdivided into four lots and placed in flasks connected with reflux condensers, and into the several flasks were poured various chemicals, viz: in no. 1, alcohol 95 per cent; in no. 2, denatured alcohol; in no. 3, ether, and in no. 4, alcohol to which had been deliberately added a very material proportion of aldehyde.

All these flasks containing the mercurosal in contact with the several liquids were then placed on a sand bath and kept heated for a period of more than twelve hours.

The mercurosal was then recovered and the toxicity of each sample was determined upon animals in direct comparison with the reserved or control sample, and the results were surprising, inasmuch as they show that mercurosal when treated with the various liquids mentioned is actually less toxic than the original control sample. You can judge for yourself from the following result:

SAMPLES	M. L. D.
	<i>gm. per kg.</i>
Rx. 717283 (commercial lot as a control).....	0.0271
No. 1 (contact with denatured alcohol).....	0.0323
No. 2 (contact with 95 per cent alcohol).....	0.0348
No. 3 (contact with ether).....	0.0360
No. 4 (contact with aldehydes).....	0.0324

It is evident that no very great difference in toxicity was developed in any one of the samples, yet the important fact appears that prolonged action with heated alcohol, aldehyde and ether does not develop new compounds nor increased toxicity. It is therefore plain that the use of grain alcohol in sterilizing syringes or skin surfaces does *not* increase the toxicity of mercurosal nor play a part in the development of systemic reactions.

GERMICIDAL TESTS

Careful and repeated tests have shown that the phenol coefficient of mercurosal against *B. typhosus* is approximately 2. The coefficient of mercury bichloride under the same conditions is about 1000. The germicidal value of this form of mercury is therefore about $\frac{1}{500}$ that of mercury bichloride, and one's first thought might be that this was very much to the disadvantage of mercurosal. It should be borne in mind, however, that the phenol coefficient of mercurosal is no indication of its spirocheticidal value nor of its clinical value in the treatment of syphilis. The low "phenol-coefficient" of mercurosal has no bearing whatever on the therapeutic value of the drug for the purpose indicated.

This drug is not a substitute for the arsenic combinations, like salvarsan and neo-salvarsan, but from a clinical standpoint might be considered a therapeutic companion to salvarsan, etc., since its chemical structure is somewhat similar to salvarsan. The origin of both is the chemical benzene ring, salvarsan is a benzene derivative of arsenic and mercurosal is a benzene derivative of mercury.

We do not wish to quarrel with long established methods of administering mercury, which have in the past and will in the future satisfy large numbers of patients and practitioners, and furthermore no claim to priority is here made, but we do welcome any additional tests that will be of value in determining mercurosal's relative standing with other popular mercurials in use.

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DISCUSSION

Dr. NEIL MOORE, St. Louis, Missouri: I have had some experience with mercurosals, having used it in a number of cases for three or four months.

We have found a great number of cases whose veins become irritated following the injection of bichloride. Some of them stand it very nicely, while others will not stand it at all. A few patients have also suffered with intestinal cramps and diarrhea following the injection of mercurosals, while others did not, although they received the same dose. It is about the only reaction I have noticed from mercurosals, and none of them has shown any irritation at the point of injection.

Dr. VICTOR D. LESPINASSE, Chicago, Illinois: One of the drawbacks in treating patients with intravenous injection of mercurials is that it acts much more on the kidney than when taken by mouth. If one is careless with bichlorid, he can produce a nephritis by the intravenous injection of mercury. I gave intravenous injection of mercury before salvarsan came into use. I cannot say very much about the therapeutic use of mercurosals from experience, but it seems to be as good as bichlorid. My cases would not allow me to draw any definite conclusions. The local reaction is less than with the bichlorid. I have followed the same technic when injecting mercurosals as with the bichlorid. The most important point is the insertion of the needle into the vein slowly.

HYDATID CYST AT THE SITE OF THE PROSTATE¹

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The rarity of hydatid cyst in the prostate area has predicated a detailed study of our own case and justified a rather complete résumé of available literature. It should be stated at the outset that our title was chosen deliberately as we were unable to determine the exact origin of the cyst which we describe.

Hydatid disease or echinococcosis, is a tapeworm disease which affects man as an intermediate host, in certain localities. It is relatively common in Iceland, Australia and South America, most of the cases reported in America being among immigrants. *Tinea echinococcus* is, however, native to American fauna. The disease was recognized fairly early in the literature, some authors tracing it back to the time of Hippocrates; pelvic hydatids were reported in English literature by Tyson in 1687. MacDonald stated in 1889 that hydatids caused one-sixth of all deaths in New Zealand.

Tinea echinococcus, the smallest of tapeworms infecting man, 2.5 to 5 mm. in length, is composed of three to four segments; the caudal is the largest, and becoming gravid, contains some 5000 eggs. Its host may be any one of twenty-seven mammals, common among which are dogs, sheep, hogs and cattle, in the order given. The eggs from the feces of animals are ingested by man, by way of food, water or direct contact with dogs, and are very resistant; they may be blown about by the wind or remain alive in water for indefinite periods. Climate is patently not a factor in the distribution of the disease.

¹ Read before the Chicago Branch of the American Urological Society.

The following is an extract of our case history:

J. K., age thirty-eight, native of Russia, five months in United States. Admitted to Urological Service, Receiving Hospital October 27, 1921, with complete urinary retention of twelve hours' duration. Temperature 99. Pulse 90. Respiration 30. No other complaint; several attempts had been made to relieve the retention with catheters. He stated that four or five years ago he had a similar illness with complete retention, which was relieved by one catheterization. Venereal disease denied. His wife and several children reside in Russia.

Upon physical examination, all findings were negative except those herewith recorded. The patient was a rather obese, red-faced, individual suffering evidently from enormous abdominal distention. Percussion indicated distention of the bladder to 3 cm. above the umbilicus; there was intense tympany laterally and in both flanks. The urethra was bleeding; in addition to several attempts at catheterization prior to his entering the hospital, the admitting physician had made a fruitless effort to enter the bladder with instruments. By rectum, no hemorrhoids were found, but a rounded mass of considerable size, occupying the prostatic region, gave immediate evidence as to the cause of the bladder incapacity. The mass was estimated as being about 4 inches in diameter, was symmetrical, hard, tender, without fluctuation or mobility. No prostatic or seminal vesicle differentiation could be made; the distended bladder could not be palpated. The examining finger failed to pass to the summit of the mass. Eight hours after admission, twenty-four hours after the onset of the retention, a filiform bougie was readily passed into the patient's bladder, but there was some difficulty in passing a silver prostatic catheter-follower. An enormous lengthening of the urethra was at once apparent and the catheter point was seen raising the abdominal wall, before urine was drawn. Bloody urine, 550 cc., was obtained, but the abdominal distention was still unabated, although the patient felt better. A second rectal examination was made with no additional evidence therefrom except that there was no fremitus over the mass. For twenty-four hours methods for relief of bowel stasis were employed; catharsis and enemata were of no avail. A rectal tube allowed almost constant passage of small amounts of gas. On the second day, another difficult catheterization having been necessary and profuse urethral bleeding resulting, a rapid suprapubic cystotomy was performed with local anesthesia. Intestinal distention had persisted; at no time during our observations was this relieved except after enterostomy.

Naturally, distention coupled with the extreme distress and obesity, made cystotomy difficult; it was accomplished rapidly, however, and the bladder examined digitally. A large non-fluctuant mass was found, apparently filling the entire bladder except for a thin pouch high up outside the pelvis. The mass was not examined by inspection at this time, nor was the urethra recognized. It was considered a prostatic tumor, consisting largely of an acute congestion with possible beginning suppuration. A tube was fastened into the bladder for drainage.

From October 28, 1921, until November 7, 1921, nine days, the patient was much improved as for comfort; he took a mild diet and drank fluids copiously. The intestinal distention continued, evidencing some relation to the pelvic mass. Bladder drainage was free.

The pertinent laboratory findings were: Urine bloody early, normal later, as drained by tube. Blood: no leukocytosis on admission, no eosinophilia, no anemia. Wassermann negative. Blood nitrogen normal. On November 7, 1921, blood chemistry:

Non-protein nitrogen, 30 mgm. per 100 cc.

Creatinine, 2.3 mgm. per 100 cc.

Uric acid, 2.7 mgm. per 100 cc.

Blood count:

Reds, 5,450,000. Leukocytes, 10,800

Hemoglobin, 90 per cent

Polymorphonuclears, 70

Large lymphocytes, 10

Small lymphocytes, 7

Eosinophiles, 3

A second operation was determined upon, eight days after the bladder drainage as the mass as palpable rectally had not been reduced in size and as the intestinal distention persisted. Repeated bimanual palpation, with one finger in the rectum, failed to demonstrate fremitus. There seemed to be definite fluctuation on the left side. Prostate and vesicles could at no time be felt.

The pre-operative diagnoses were prostatic abscess, tumor, or cyst, abscess seeming most probable. Therefore on November 7, 1921, a perineal incision was made and a laborious approach to the prostatic area ensued. Severe hemorrhage was encountered, together with a loss of all normal structural landmarks. When the prostatic area was reached, no fluctuant mass appeared, rather a very dense hemorrhagic inflammatory wall of tissue. Suprapubic inspection was then decided upon and the old wound with that of the bladder, widely opened. In-

travesical palpation revealed in addition to a bladder wall very much thinned out, above, and hypertrophied in its lower segment, the mass as described, pushing up into the bladder. Inspection immediately enabled exact diagnosis, in that the prostate per se was ruled out. The surface of the mass was glistening white, covered by an extremely thin bladder wall. Evidently we were dealing with a cystic tumor; the urethra was carefully searched for, but not recognized. The mass was adjacent to the symphysis above and against the sacral protuberance posteriorly; the bladder of course lay above. The urethra was flattened out laterally, leaving the pelvis below the point of possible palpation.

Pointed scissors were thrust into the cyst, allowing the immediate escape of some 1500 cc. clear fluid with numberless small grape-like cyst-bodies, varying in diameter from one-half to many centimeters. The opening was enlarged and many handfuls of the small free cysts, with more free fluid, were evacuated. Palpation then disclosed several larger cysts attached to the inner wall of the mother cyst. These were removed. The mother cyst wall consisted of two distinct layers, the inner of rough surface, and thicker, the outer quite smooth. The cyst wall was freed partially from the posterior bladder wall and a considerable portion excised, leaving a flattened cavity supposedly empty, communicating freely with the bladder. A large tube, fenestrated for bladder drainage, was then placed in the cavity comprising cyst and bladder, and the latter closed. Care was taken to see that the peritoneum had not been opened. The perineum was closed.

The operation was difficult on account of the extreme intestinal distention. The post-operative condition was good. After twenty-four hours however, distention increased, in spite of renewed efforts for bowel evacuation. Fluid intake was excellent, urine drainage good, and there was no vomiting. Sigmoidoscopy proved complete patency of transverse and descending colon. The patient rapidly lost in weight and strength, and on the third day enterostomy with intraperitoneal exploration was performed (November 10, 1921). The peritoneum was opened through a right rectus incision. There was a small amount of free fluid; also fibrinous exudate attached to the enormously distended small intestine. The latter was opened allowing the release of a great deal of gas and fluid, the evacuation of which was further facilitated by passing a tube into the intestine. Exploration of the liver was negative as was that of all the abdomen save the pelvis. Here, however, we found mesentery, intestine and cyst wall with extensive adhesions of

long standing. After separation bluntly of the cyst wall laterally, the drainage tube was found free in the peritoneum, having broken through bladder and cyst wall, probably at their junction. The intestine greatly impinged upon, was almost gangrenous and was freed with difficulty, and the enterostomy completed, leaving a large drain in the area of localized peritonitis. The bladder tube was removed. A few small cysts were found free in the pelvis. Within a few hours the distention had subsided; the patient continued to waste, however, in spite of apparent arrest of the peritonitis. Urine drainage continued good; no vomiting occurred, the patient retaining large amounts of fluid. Urticaria did not develop. He became stuporous on the fifth day after the enterostomy and died the morning of the seventh post-operative day, November 17, 1921.

A complete autopsy was not obtained; the two abdominal and the perineal incisions were reopened and the kidneys, ureters, bladder and urethra, with attached cyst were removed in toto. The autopsy report follows:

The midline suprapubic incision was reopened for exposure of bladder and cyst. The left kidney was freed and delivered through this wound prior to enucleation of the cyst and dissection of bladder. Exploration of the pelvis disclosed a section of small intestine approximately 18 inches long, the wall necrosed. This was recognized as the area of adhesion to the cyst, separated at the time of the operation for intestinal obstruction. Deeper in the pelvis other adhesions were found between the sigmoid and the small intestine. Recognition of the peritoneum was not possible, due to operative procedure. After the separation of the adhesions referred to the cyst was readily delivered from the pelvis and found to be only slightly adherent to the rectum, but intimately connected with the posterior wall of the bladder. The bladder was then freed anteriorly and laterally by sharp dissection, delivering it. The vas on each side was recognized entering the inguinal canal. Internally the vas on each side merged with the bladder wall. The perineal wound was then reopened, and the posterior urethra dissected free.

The upper abdominal incision was also reopened permitting delivery of the right kidney, which with its ureter was pulled down into the lower wound. A complete specimen consisting of both kidneys, ureters, bladder, cyst and posterior urethra was then removed in toto.

The left kidney contained pus and had been freed with great difficulty due to adhesions; it was smaller than normal and gave evidence of acute beginning suppurative nephritis. The left ureter was distinctly shorter

than the right and slightly dilated. The right kidney and ureter were apparently normal.

The distinct layers of the cyst wall were recognized with connective tissue forming a distinct layer between these and the rectum and bladder. Separation of the cyst from the bladder wall proved a simple matter, indicating that the connection was not very definite.

Prostate and seminal vesicles could not be recognized, having been evidently destroyed by developing cyst; several small daughter cysts were found during the moving of the specimen, free in the cavity. The liver was examined and found free of cysts; a portion was excised for histological study. No evidence of extra-pelvic hydatid.

Pathological diagnosis echinococcus cyst. Following the second operation the diagnosis of hydatid cyst was confirmed by the pathologist from examination of the fluid and the cyst wall as well as the daughter cysts. Hooklets were not found. The fluid contained no sugar. Microscopic tissue studies were made and typical cuticular and germinal layers recognized. Sections of the posterior bladder wall opposite the normal site of the seminal vesicles showed a tiny bit of these structures remaining, atrophic to an extreme degree. The cyst wall and bladder wall were both negative for vestigial prostatic tissue. Neither vesicles nor prostate could be recognized in the gross specimen.

Conjecture fails to establish the origin of the cyst in our patient's pelvis. Two views have been accepted as to the path of the embryo from the human stomach. It is conceded by all that the membrane covering the embryo is dissolved by the gastric juice, allowing the organism to burrow through the mucosa, aided by its hooklets.

Thence, according to one theory it enters the circulation to be lodged most frequently in the liver, where the majority of cysts occur. This is accepted by all and accounts for cysts in various parts of the body. The second theory, namely, that the embryo gains direct access to the peritoneal cavity and gravitates to the pelvis for instance, or burrows into the liver, is of doubtful value.

Sir Henry Thompson thinks this latter theory untenable, and states that all pelvic cysts are retroperitoneal, evidencing hematogenous origin. Our own case is supportive to this idea inasmuch as the cyst was purely retro- and infraperitoneal.

It seems doubtful if hydatid cysts ever originate in the prostate. Fenwick in 1894 reported four cases recorded in the literature up to that time; of these only one admitted of being purely prostatic, according to him. Sir Henry Thompson doubts



FIG. 1. COMPLETE SPECIMEN; BLADDER SHOWN PUSHED UPWARD BY CYST

Note small left kidney, with infiltrated fatty capsule, dilated left ureter. Cyst wall was partially resected at operation, but has hardened around cotton stuffing. In vivo, openings in bladder and cyst were opposite one another.

this case, being emphatic in his opinion that the prostate is not a site of origin.

In 1897, R. H. Martin of Australia, reported a case of multiple pelvic hydatid cysts and stated that per rectum the prostate

was felt with numerous small cysts attached. The bladder was completely obstructed by larger cysts which were successfully opened through a perineal incision.

In 1901, Bangs, in the *Annals of Surgery*, described a case of hydatid cyst which merged with the left lateral lobe of the prostate and extended upwards between bladder and rectum. He considered the prostate the primary origin but gave no conclusive evidence. Yet, as if to make his case an exception he refers to seven cases in the French literature, doubtful as to prostatic origin, and to Sir Henry Thompson's opinion thus: "He is inclined to think that all cases of hydatid of the prostate are hydatid between the rectum and bladder, the prostate having been more or less absorbed by pressure from the external cyst, so that the latter comes at length to occupy the seat of this organ."

Guiteras in his text book published in 1912, stating that hydatid cysts in the pelvis are very rare, reported two personal cases, in one of which the prostate was not differentiated from the cyst.

In order to ascertain the relative frequency of pelvic hydatid, a few statistics may be of interest. Osler and McRae in 1914, state the involvement in 1284 cases as follows:

Liver.....	1011
Kidney.....	126
Lung.....	147
No pelvic cases cited.	

An earlier writer, Fenwick, enumerates the sites of cysts in 1634 cases as follows:

Liver.....	820
Lung and pleura.....	137
Abdominal organs including kidney, bladder, etc.....	334
Nervous system.....	122
Circulatory system.....	42
Other organs.....	179

Fenwick also differentiates 51 pelvic hydatid cases collected from necropsy reports thus:

Between posterior wall of bladder and rectum.....	22
Between neck of bladder and rectum.....	4

Prostatic (all doubtful).....	4
Pediced to posterior bladder wall.....	1
In cellular tissue, right seminal vesicle.....	1
To right of bladder 1; on either side of bladder.....	2
To apex of bladder.....	2
Vesical orifice of each ureter.....	1
Between bladder and uterus.....	5
Between uterus and rectum.....	3
Between vagina and rectum.....	1
To uterus and surrounding.....	1
To the mesorectum.....	3

In 1914, L. E. Barnett in the New Zealand Medical Journal reviewed briefly all literature of Australasia, France, Germany and the Argentine Republic, and fails to mention any pelvic location.

From the foregoing statistics it is easy to see with what comparative rarity an hydatid cyst is found located in the pelvis. However, many undoubtedly exist unrecognized as pelvic and abdominal cysts notoriously evade diagnosis in vivo, and as hydatid like other cysts may exist many years without inconveniencing the host or endangering life. Fenwick refers to a case of forty-five years standing, while Osler gives the average duration as two to eight years. We have collected approximately 281 cases of hydatid disease in United States and Canada, and of these, 91 per cent of the patients were immigrants. Up to 1902, 16 cases of pelvic hydatid had been reported in America. References to 5 later cases will be given below.

As to age incidence, 74 per cent of cases occur in the middle aged and young adult; the extremes reported are three months and seventy-four years. As to sex incidence, abroad the ratio has been given as 3 females to 2 males. In America it is the reverse, probably due to a predominance of male immigrants. Of greatest importance in the study of pelvic hydatid in the female is its relation to pregnancy. Every possible complication has been recorded, some form of dystocia being most frequent. Regardless of sex, there are three factors of importance as to significant symptoms and prognosis in pelvic hydatids:

1. Constipation from rectal pressure
2. Bladder irritability preceding suppression
3. Bladder obstruction culminating in retention

Fenwick stated that bowel stasis alone rarely occurs, citing one case where it was a definite finding preceding urinary retention. R. A. Stirling of Australia in 1897 reported a case in which the bowel was completely occluded. Intestinal adhesions are commonly reported, but our case is the fourth so far as we know, where complete obstruction was apparent.

Bladder irritability and retention may be preceded by insidious dilatation of the ureters and kidney pelves, the condition recognized only in the terminal stage of renal infection.

The prognosis of pelvic hydatids has ever been variable; of those recognized during life, the direct mortality has been high. Up to 1833, all reported cases were fatal; however, of recent years, since the adoption of the no-drain operation of Bond, the mortality has been relatively low, death depending largely upon rupture of the fluid into the peritoneum (a factor in our case), and the pressure effect upon the kidneys, ureters or bowel.

The diagnosis of this condition depends upon too many factors to admit detailed discussion here. J. E. Barling and D. A. Welsh of Australia give a symptom-complex for ruptured, abdominal, intraperitoneal cysts, as follows:

1. Eosinophilia, 50 per cent or more
2. Free fluid in peritoneum and severe peritonitis, usually fatal
3. Urticaria

Our patient did not develop eosinophilia or urticaria, but relatively little fluid escaped into the peritoneal cavity. There was, however, enough to make anaphylaxis a part of his lethal enemy in the form of leukomains known to be elaborated by hydatids.

Welsh and Chapman in 1908 described a technique for a precipitin reaction, using the serum of the suspected patient with hydatid fluid, and stated that all proven cases give positive reactions. J. F. Flashman and A. G. Butler of Australia in 1910 gave accurate data regarding their work and that of Weinberg and of Guildim, preceding Weinberg, upon a complement fixation test, which is now recognized at least for its positive evidence. It necessitates a supply of hydatid tissue.

The abdominal and pelvic cysts vary so much in size, location and duration as to make diagnosis difficult. In 1891, R. H. Jones of Australia removed 20 pints of fluid from a cyst, and daughter cysts to the number of 27,520. Fenwick refers to a pelvic cyst containing 20 litres of fluid, and to another weighing 12 pounds, while Osler mentions abdominal cysts weighing 45 pounds. Migrating (?) pelvic cysts have been found in inguinal herniae and in the scrotum. A number of instances of cysts rupturing into the bladder, are recorded, including the first reported case, of Tyson, and a case reported by J. B. Squier in 1915. Keyes refers to this fact, stating that cysts very rarely begin in the bladder wall.

In practically every instance where the cyst occupied the prostatic area it was considered pathology of the prostate itself until the time of operation. Guiteras detailing his two cases, originally considered one as prostatic abscess, the other as an hypertrophied prostate.

Aspiration with examination of the fluid for hooklets and sugar, should make the diagnosis, but this procedure is condemned, and while the finding of either sugar or hooklets is confirmatory, negative findings are valueless. Bladder diverticulum, prostatic sarcoma, syphiloma or abscess comprise the list for differential diagnosis in the male.

The accepted treatment of pelvic hydatid is radically surgical. Approach to the cyst is made preferably suprapubically and retroperitoneally. The cyst is opened, evacuated and its wall completely dissected out if possible. Otherwise the germinal layer is removed and the outer layer closed or drained as exigency demands, no drainage giving better results.

SUMMARY

1. Hydatid cyst occurring singly at the site of the prostate is rare; symptoms always follow some obstructive phenomena with pressure upon bladder, urethra, ureters and bowel.

2. The prostate has not been proven as the origin of any recorded cyst. Dissection usually shows the cysts to be situated more or less continuous to the posterior bladder wall,



FIG. 2. SHOWING ANTERIOR AS WELL AS POSTERIOR OPENING IN BLADDER WALL
Note urethra also, and comparative size of kidneys



FIG. 3. LATERAL VIEW OF SPECIMEN

possibly arising in the cellular tissues between muscle and peritoneum, or more often, in the angle between this layer, the rectovesical sheath and the posterior border of the prostate.

3. In our case the origin was probably the latter mentioned.

4. The majority of cases of hydatid disease in North America occur in immigrants, indicating infection in foreign lands and slow development of the cysts.

5. The disease is difficult of diagnosis except where it occurs frequently enough to provide for such methods as the complement fixation test.

6. The accepted treatment is surgical removal of the cyst fluid, daughter cysts and germinal layer of the cyst wall.

7. In the case herewith reported, no hooklets, scolices, or sugar were found. The patient had neither an eosinophilia nor an urticaria following peritoneal leakage.

8. Three factors were responsible for the death of the patient; intestinal obstruction, infected pyelonephritis and general peritonitis.

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DISCUSSION

Dr. BRANSFORD LEWIS, St. Louis, Missouri: This is a very interesting contribution, and I can particularly appreciate it because I have seen one case of hydatid cyst, and only one, which was an importation on the part of an Italian woman from Sicily. Dr. William E. Leighton, of St. Louis, and I reported this case, having operated on it together about twelve or fourteen years ago.

I can confirm, so far as this one experience entitles one to generalize, the fact, that our ability to diagnose these cases is limited. We had not the remotest idea of what the true pathological condition was when we started to operate. We explored. We thought there was some form of kidney tumor, and although the diagnosis was far beyond us before we got in, when we opened up this cyst we found cysts of varying sizes, from the size of a pea up to the size of a walnut. The multitude of cysts came cascading out of that large cyst pell-mell. The cysts had a flexible membrane. Neither of us had ever seen such a condition before. However, we promptly surmised it was an hydatid cyst.

If I should see another one, I would not be impatient to get the thing out in one operation as we did. We worked hard and got the cyst out, which involved the kidney in this case. "The operation was successful, but the patient died within three or four days thereafter."

It strikes me from our knowledge of our own case and the report of Dr. Cumming, it would be a little more conservative to drain the cyst first, and after restoration of the condition to get rid of the balance. That was our main deduction by the handling of that case.

Dr. WILLIAM T. BELFIELD, Chicago, Illinois: I once saw a patient who had complete retention of urine, dilated bladder

and ureters. The only cause of obstruction discovered was a fluctuating tumor just above the prostate, which I suspected to be a cyst of the utricule—variously reported as cysts of the seminal vesicles.

A small trocar and cannula introduced into the cyst from the rectum gave exit to clear fluid containing much albumen. Exploratory approach through the perineum, was advised but prohibited by the patient's condition. Death from urosepsis occurred. This may have been an echinococcus cyst.

Dr. VICTOR D. LESPINASSE, Chicago, Illinois: I have never had a case of echinococcus cyst in this location, but happened to have had one that came from the kidney. It took very little skill to make the diagnosis in my case. This man came in with a history of passing grape skin-like material from the urethra following an attack of pain in the side. When we examined the material we saw what it was. Then I obtained some echinococcus livers and made an antigen, tested out this patient's blood, and found his blood was three plus positive with the complement fixation that Dr. Cumming spoke about. The patient was an Austrian, twenty-seven years of age. He always had had some kind of dog around the house.

Dr. CUMMING (closing): I was afraid there was going to be adverse discussion in regard to the handling of this case. I was very much impressed with the remarks made by Dr. Lewis concerning the way these cysts tumble out. Dr. Plaggemeyer did the perineal part of the second operation, and I re-opened the abdominal wound. When the scissors were thrust into the cyst wall, daughter cysts came pouring out, and Dr. Plaggemeyer was immediately interested again, seeing the many handfuls of cysts.

Dr. Lewis referred to many mother and daughter cysts. There is only one mother cyst in these cases; that is, a multilocular hydatid cyst in the human is rare. It is occasionally recognized. There is one mother cyst and endogenous daughter and grand-daughter cysts, *ad infinitum*.

I referred to intestinal distention in my paper with the idea that distention was an essential factor in our case, and complete intestinal obstruction was relieved by the enterostomy. Drainage of the cyst per rectum was the treatment in the earlier cases. Later cases were treated by aspiration and a few recoveries were reported. Up to 1833, all pelvic hydatid cysts that were recognized were rendered fatal by operative treatment or died during the operation. Aspiration is condemned. It has caused immediate absorption by the blood of the leucomain elaborated by the cyst and immediate shock up to the point of death has occurred.

With regard to the remarks of Dr. Lespinasse, certain cases of hydatid cysts of the kidney and bladder have drained themselves and it has been unnecessary to operate. It was true in his own case. A New York surgeon reports a case in which the cyst ruptured into the bladder, and many of these grape-like cysts were obtained from the urine. He had a difficult problem in discovering where the cyst was. It was attached to the posterior wall of the bladder. Our idea was to drain the cyst first. We dissected free a part of the wall in order to make a diagnosis and to make the opening a large one, with the idea later of further dissecting the wall if necessary. However, intestinal obstruction and peritonitis made the story a different one.

THE ENDOSCOPIC DIAGNOSIS OF MINOR DEGREES OF PROSTATIC OBSTRUCTION AND THEIR TREATMENT PER URETHRAM¹

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When confronted with a case of moderate or beginning prostatic obstruction, it is not always easy to determine whether or not a true adenomatous enlargement is present. Rectal palpation not infrequently fails to discover any noteworthy enlargement or hardness of the gland. Indeed many simple inflammatory conditions will furnish prostates which may feel considerably larger and even harder than certain others which contain the true adenomatous growth.

A slight elevation of the vesical orifice with lengthening of the posterior urethra may escape detection on catheterization or instrumentation and furthermore both conditions may be present in simple inflammatory processes. A residual urine tells us nothing as to the nature of the obstruction which gives rise to it nor on the other hand does the absence of a residuum necessarily exclude the presence of an easily demonstrable adenomatous hypertrophy.

We resort to the cystoscope, but indispensable as this instrument is in the diagnosis of prostatic hypertrophy, we should never forget that with it we see everything of importance except the prostate itself. This we do not see. The sphincter margin as seen through the cystoscope is a silhouette of the vesical margin of the prostate. When deeply notched or presenting gross convexities, especially those necessitating an advance and retraction of the cystoscope in order to follow them, such a silhouette may

¹ Read before the Chicago Branch of the American Urological Society, February 24, 1922.

be sufficiently informative, but it bears the same relation to an endoscopic picture of the prostatic urethra as that borne by the ordinary black and white shadowgraph of the human profile to the full front photographic picture. There is indeed no one characteristic of the sphincter margin as seen through the cystoscope which can be said to be absolutely diagnostic. Slight notches may occur in inflammatory processes. Convexities, especially below and associated with notches, may be seen in inflammatory processes, and such a cystoscopic picture may be accompanied by an appreciable amount of residual urine without the presence of any true adenomatous hypertrophy.

That surgeons of wide experience do actually get into difficulties is sufficiently proven by the number of sclerotic or atrophic prostates which we hear of colleagues attempting to enucleate. They do not tell us beforehand that they are going to enucleate a sclerotic prostate, but they tell us afterwards that they ran into one. It would be reassuring if we could make our diagnoses in advance. I do not mean to say that a sclerotic prostate never requires an open operation. Some of them undoubtedly do, though the operation required will seldom be that of prostatectomy. But surely before determining the point in any given case the surgeon should exhaust every means at his disposal to make an accurate diagnosis of the nature of the lesion with which he has to deal.

In the modern irrigating endoscope we have a means of examining the entire urethral surface of the prostate. We do not get a mere sky-line of one edge of it, but we see it at a correct focal distance, satisfactorily illuminated from the vesical orifice down to the verumontanum. The picture presented by the adenomatous prostate is so characteristic that doubt as to the diagnosis appears virtually impossible.

The technique of examination is very simple. A straight direct vision irrigating endoscope is introduced into the bladder. A beaked instrument or one presenting a lateral view will not serve the purpose. Irrigation is established and the instrument slowly withdrawn until a portion of the sphincter margin comes

into the field of vision. A note is made as to which portion of the sphincter margin appears first. An attempt is then made to bring the entire sphincter margin into view at once. In the normal individual this is easily accomplished but where the vesical orifice is elevated and its plane tilted abnormally it becomes exceedingly difficult. Extreme depression of the ocular end of the instrument is necessary, and then it may not be possible to obtain a close up vision of the superior segment. The attempt however tells us something of the dislocation that has occurred. Many inflammatory conditions and scleroses as well as prostatic hypertrophies present this abnormality. The instrument is then slowly withdrawn. The normal vesical orifice will appear as a circular hole which opens and shuts with the establishment and interruption of the irrigating stream. In sclerotic and inflammatory conditions it will appear more or less deformed, sometimes triangular and sometimes flattened below like an arched doorway. Under normal conditions the entire deep urethra as far forward as the verumontanum will present the same circular opening which tends to close over the end of the instrument. The mucous membrane appears soft and pliable and the channel opens up symmetrically when the irrigating fluid is allowed to flow. Where inflammatory processes are present, the prostatic lobes may give a slight convexity to the lateral walls of the urethra, but this convexity is not as a rule fixed but yields to the pressure of the irrigating fluid. The mucous membrane still appears pliable, and the entire lumen of the urethral canal remains visible in a single endoscopic field. This is a picture altogether different from the firm rigidity observed in cases of true hypertrophy. Here we find the urethral walls rigid and smooth. The mucous membrane no longer falls in little plications over the end of the urethroscope, but the urethral canal widens or contracts in response to varying degrees of pressure by the irrigating fluid, as if masses of polished stone had been thrust aside and permitted then to fall back into their original position. Indeed, the entire prostatic urethra may present the appearance of a narrow vertical slit between two pink onyx columns. The

height of this slit has to be estimated by moving the tip of the endoscope up and down so as to bring first the floor and then the roof of the urethra into view for they are widely separated. Sometimes the canal is straight and sometimes tortuous. Sometimes a middle lobe is present on the floor at the vesical orifice but it does not extend down very far into the urethra. Both lateral lobes are in my experience always involved but one of them may have encroached upon the other giving the urethral slit above described a crescentic shape.

This endoscopic appearance occurs early in prostatic hypertrophy and I believe that a diagnosis of prostatic hypertrophy should never be made in its absence. It is not found in cases of simple median bar obstruction, even though the median lobe may appear rounded on cystoscopic examination and present notches to each side. Thus far I have never seen a case of true adenomatous hypertrophy confined to the median lobe. If such a condition occurs it ought certainly to be recognizable through the endoscope.

Having followed the urethra as far downward as the verumontanum, we have formed a very clear idea of the degree of lengthening of the deep urethra, the course of it, the amount of elevation of the vesical orifice, and the degree of tilting of its plane. This should give us a very clear conception of the mechanical nature of the obstruction in every given case and if any operation less than prostatectomy is contemplated we ought now to know just where to strike. It is not my purpose to discuss here the relative merits of prostatectomy and various palliative operations. I wish merely to point out that no palliative operation is rationally conceived which does not take account of the mechanics of each individual case, and endeavor to correct the particular mechanical difficulty which is present.

If true hypertrophy has been excluded and we are dealing with a simple elevation of the vesical orifice from sclerosis or if without elevation of the orifice, a simple median bar is present, the indications are perfectly clear, and the burning or punching out of a groove on the floor of the orifice should meet the mechanical

requirements of the case. If, however, a true hypertrophy confronts us, such a procedure will be insufficient or perhaps even entirely misdirected. Here it is the two lateral lobes which are chiefly at fault, and there may be no involvement of the median lobe, or if the median plays a part it is merely that of a cobblestone between two boulders. Our endoscopic examination has shown us whether or not the median lobe plays a part and how far it extends down into the urethra. Below that we have seen the smooth massive pillars of the two lateral lobes. We have seen which one encroaches most upon the urethral canal and have estimated how much tissue would have to be removed to straighten out the canal. We have observed the amount of increase in the vertical diameter of the prostatic urethra as well as the increase in its length from the bladder to the verumontanum. We are therefore in a position to judge as to whether or not we can burn out or punch out enough tissue to give a fair prospect of relief to our patient.

As for methods of operating a great variety of apparatus is available. I shall not attempt to discuss them but simply offer my own device as supplemental. This was described before the southwestern branch of our association in Kansas City last October. It consists of the familiar punch of Dr. H. H. Young in connection with which I use a stiff fulgurating needle. The piece of tissue to be removed is caught within the fenestrum of the punch and then tranfixed by the fulgurating needle. It is thoroughly needled and coagulated and then punched out. The same ultimate result is obtained if the burned tissue is merely left to slough away, but I find there is no hemorrhage where it is brought away at once and there appear to be certain advantages in doing so. However there are other methods of accomplishing the same purpose. The point I wish to make is the importance of a preliminary endoscopic examination to establish first the character of the lesion, whether or not a true hypertrophy is present, and second the nature of the mechanical obstruction to urination, in order that we may intelligently plan our operative procedure with a view to its removal.

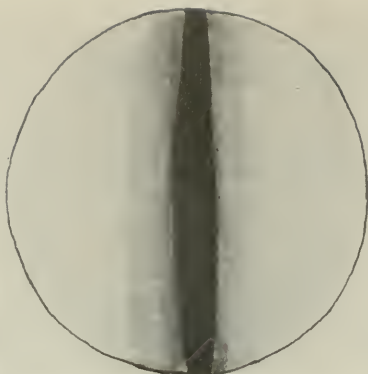


FIG. 1

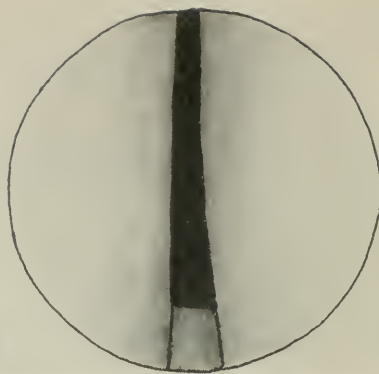


FIG. 2

FIG. 1. APPEARANCE OF VESICAL ORIFICE IN A CASE INVOLVING THE LATERAL LOBES ONLY

Note that the vertical slit between these two pillars is too long to be visible in a single endoscopic field.

FIG. 2. SAME CASE AS FIGURE 1

The endoscope has been withdrawn a little and the floor of the vesical orifice is coming into view. The futility of a punch operation on the floor in such a case is apparent.

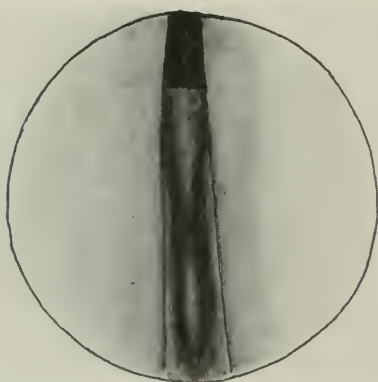


FIG. 3



FIG. 4

FIG. 3. SAME CASE AS FIGURES 1 AND 2

The endoscope has been further withdrawn. A ridge-like elevation is seen tapering down into the urethra on the floor.

FIG. 4. SAME CASE AS FIGURES 1, 2 AND 3

Note that the smooth massive columns of the hypertrophied prostatic lobes continue as far forward as the verumontanum. This prostate was described on rectal palpation as of normal size but of uneven consistence, being hard above. The secretion contained considerable pus. Residual urine $\frac{1}{2}$ to 1 ounce. Cystoscopy revealed a slight notch above and two below, with slight convexities on the sides.



FIG. 6



FIG. 5

FIG. 5. A VESICAL ORIFICE WITH BULGING OF THE RIGHT LATERAL LOBE
 FIG. 6. TYPE OF TORTUOUS URETHRA WHERE THE CANAL GOES AROUND A PROJECTING LOBE

Note, however, that both lobes are hard and smooth



FIG. 7



FIG. 8

FIG. 7. ANOTHER TYPE OF VESICAL ORIFICE

Note how the sphincter muscle appears to have slipped off the enlarging prostate and is visible covered with mucous membrane.

FIG. 8. A MEDIAN LOBE COMING INTO VIEW BEFORE THE LATERAL LOBES ARE VISIBLE



FIG. 9

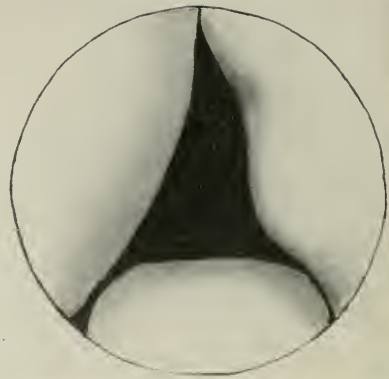


FIG. 10

FIG. 9. SAME CASE AS FIGURE 8

The left lateral lobe is appearing as the endoscope is further withdrawn

FIG. 10. SAME CASE AS FIGURES 8 AND 9

Both lateral lobes have now appeared



FIG. 11



FIG. 12

FIG. 11. SAME CASE AS FIGURES 8, 9 AND 10

The middle lobe is receding to give place to the two lateral lobes. Shortly below here it passes entirely out of the field of vision.

FIG. 12. A VERY SMALL VERUMONTANUM AT THE END OF A TORTUOUS PROSTATIC URETHRA

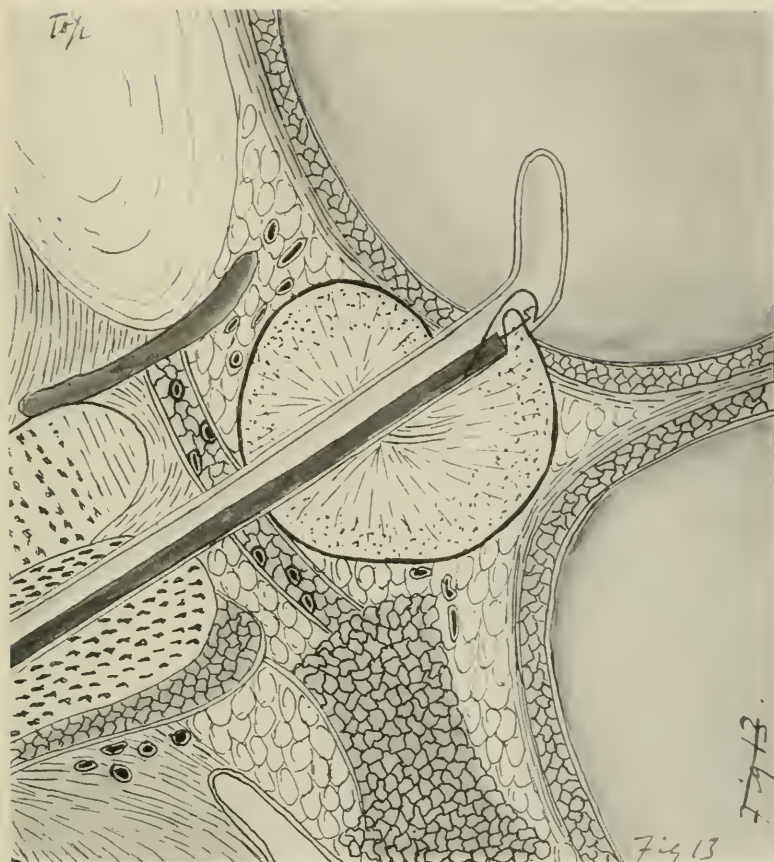


FIG. 13. INCORRECT POSITION OF FULGURATING NEEDLE

The needle has been thrust in too far and the spark is passing from the needle to the metal of the punch. This makes a loud crackling sound, quite different from the sizzling noise heard when the needle is correctly placed.

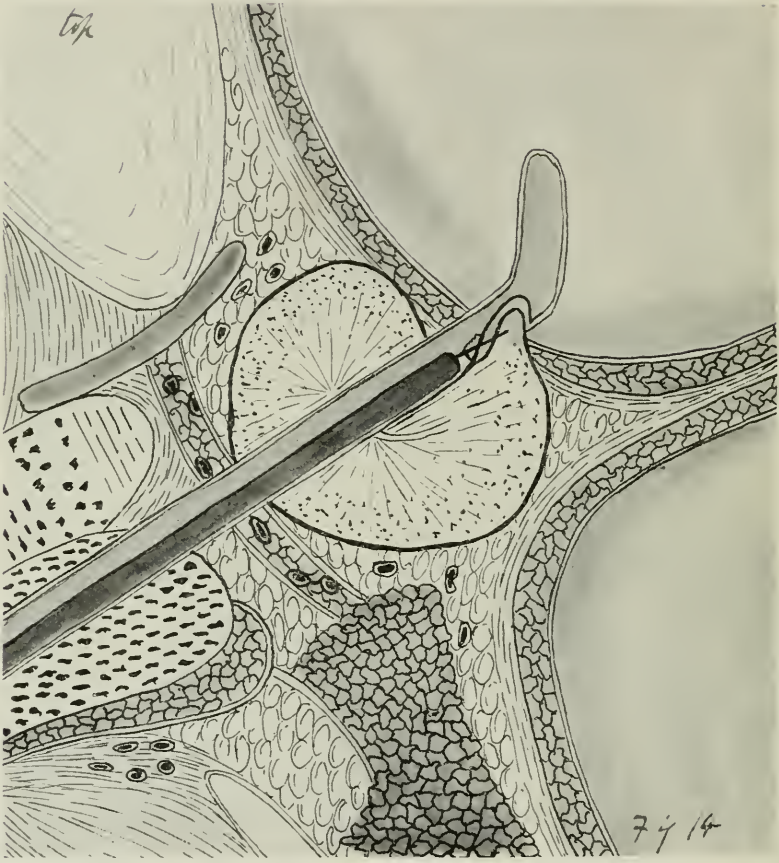


FIG. 14. ANOTHER EXAMPLE OF INCORRECT FULGURATION

The needle is insufficiently advanced and there is a spark to the metal of the punch.

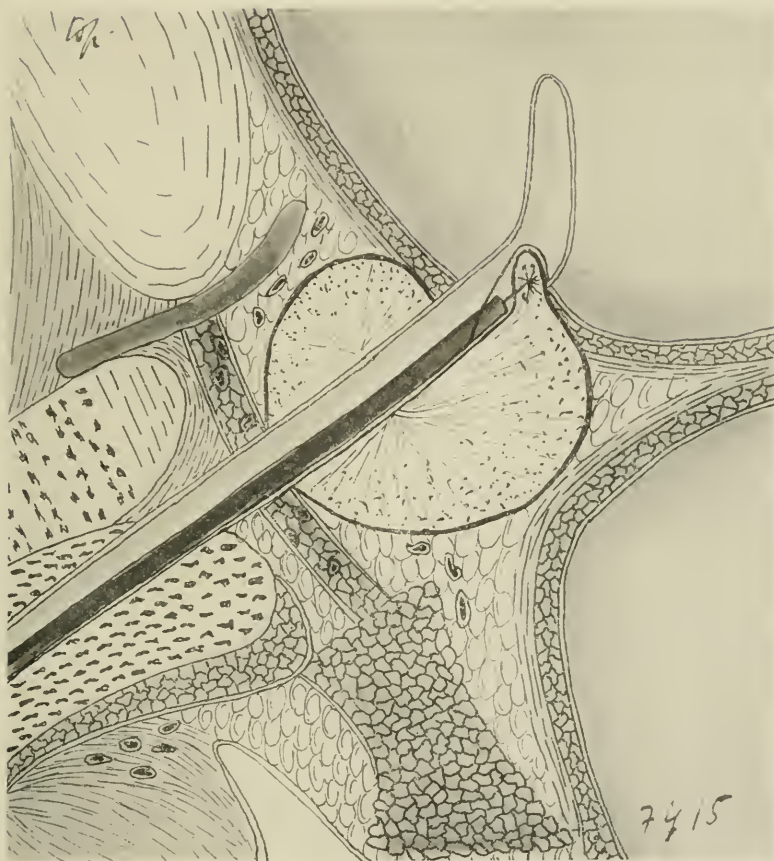


FIG. 15. CORRECT POSITION OF FULGURATING NEEDLE

When so placed the noise heard is the subdued sizzling sound of burning flesh. This gives us a very good index of the position of our needle.

THE ACTION OF BENZYL BENZOATE AND MORPHINE ON THE VESICAL SPHINCTER

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In cases of urinary retention it is important to obtain voluntary urination. In a number of clinical cases this has been accomplished by the use of benzyl benzoate. It has been stated by a few pharmacologists that morphine produces the opposite effect, bladder distention, so it naturally falls into this discussion. In the laboratory I attempted to find the action of these two drugs on the vesical sphincter. The problem outlined for my experiments was as follows: At the suggestion of Dr. Reid Hunt, morphine was first given to raise the sphincter tone. Benzyl benzoate was then administered in the attempt to lower the sphincter tone. Benzyl benzoate was also given without morphine to determine its effect upon the normal sphincter tone. This experimental work was done on rabbits.

In brief, the experiments were carried out in the following manner. The animal was anesthetized with urethane given by a stomach tube in a dosage of 1 gram per kilogram body weight plus 0.5 gram. The animal was kept warm by an electric pad. The bladder was exposed by a small incision in the abdominal wall and a small cannula introduced through its anterior and upper surface thus avoiding the large arteries that run along the lateral walls and upper pole. Very little traumatism was produced for it was necessary to make only a very small opening by thrusting the point of a scalpel through the vesical coats and then tying the cannula in with two purse string sutures which were placed with a small curved needle. The cannula was then connected with a burette containing normal saline at the rabbit's

body temperature and to a manometer by means of a three-way stop cock. Normal saline was then introduced into the empty bladder until the intravesical tension rose above that of the sphincter. This was indicated by the passage of fluid from the external meatus. Both the intravesical tension and the amount of fluid introduced were recorded at this point. Several normal readings were taken. After the normal tone of the sphincter and the amount of the fluid necessary to overcome this tension was determined, morphine was given subcutaneously and several more readings taken to see the effect produced on the sphincter. In all the experiments except those in which benzyl benzoate was given prior to the morphine there was a marked rise in the sphincter tonus; in some cases this increases several times its normal value. To give an idea of the change produced in the sphincter I will review one or two experiments.

In one experiment the normal sphincter tone was 3.6 cm. water pressure but was increased to 10.6 cm. water pressure after the subcutaneous administration of 15 mgm. of morphine. Two cubic centimeters of the 20 per cent alcoholic solution of benzyl benzoate were given by a stomach tube and the readings repeated. The sphincter tone was reduced to 3.5 cm. water pressure in ten minutes. Ten minutes later the reading was 5.4 cm.

In another case the normal sphincter tone was 5.5 cm. water pressure. This was raised to 26.5 cm. after morphine was given and reduced to 9.5 cm. thirty minutes after benzyl benzoate was given.

In all cases a ten-minute rest was allowed after each reading. The effect of morphine occurs in a few minutes and is indicated by a rise in the sphincter tone. The maximum effect of benzyl benzoate is noticed in ten to twenty minutes after its administration as a rule. It is indicated by a fall in the sphincter tone which, however, soon rose again.

Rabbits take morphine well. Fifteen milligrams may be given and 30 mgm. were given several times without fatal results. In two cases I gave benzyl benzoate before the morphine and in both cases morphine failed to raise the sphincter tone even though 30 mgm. were given. The inability of the morphine to increase

the sphincter tone when given after benzyl benzoate persisted for over two hours in one case. This would suggest the possibility of giving benzyl benzoate prophylactically preceding morphine.

It was indicated in the experiments just cited that after the effect of morphine is recorded, benzyl benzoate is given by stomach tube and the same readings repeated. In all experiments

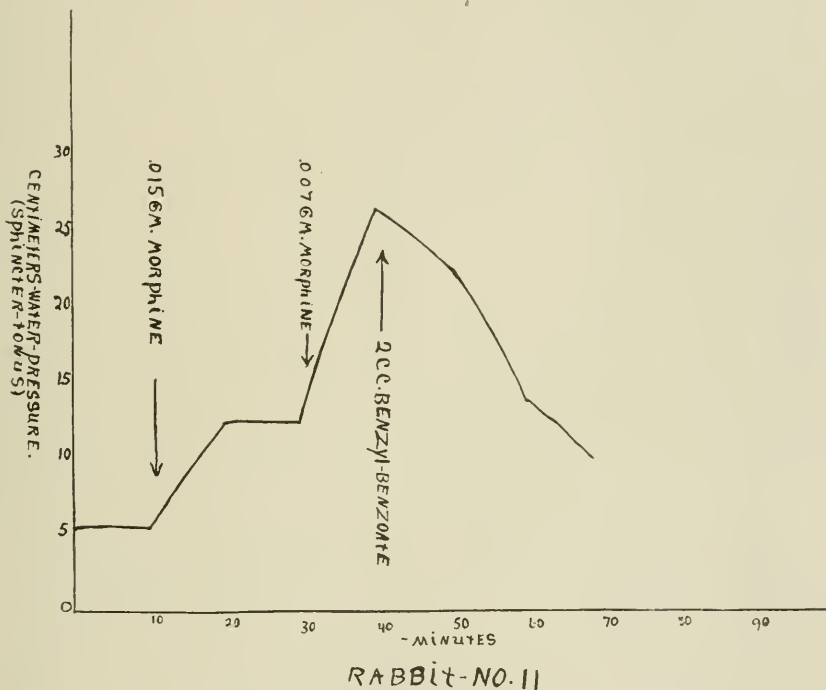


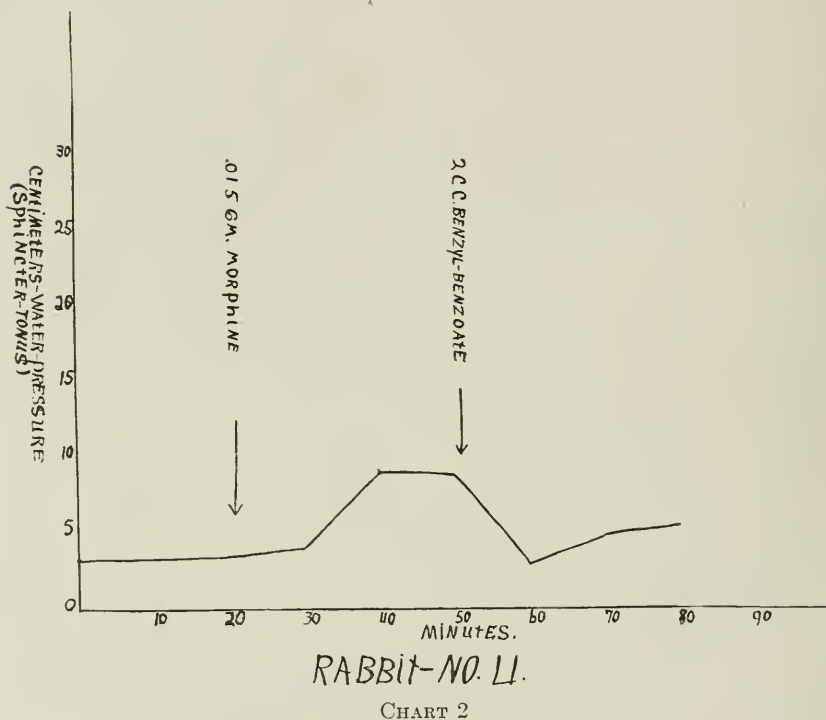
CHART 1

the sphincter tone was lowered after giving this drug and could be reduced almost to its normal value.

In the accompanying charts the effects of the two drugs on the vesical sphincter are shown. The results of two typical experiments were used in constructing the charts. There were ten similar experiments.

It has been debated whether or not morphine produces bladder distention. A few pharmacologists have found that it does. Tappeiner stated, in 1899, that if morphine be given to a guinea

pig in fairly large doses the bladder would rupture and voluntary urination would not occur. Czapek and Wassermann (1), in 1914, reported a case of bladder distention occurring after the use of morphine. There have been a number of cases of post-operative bladder distention analyzed in an attempt to find the part played by morphine in producing the distention. In the rabbit



morphine definitely raises the sphincter tonus. The action of morphine in the production of spasm of the vesical sphincter is said to be due to depressed inhibition. This would occur through the pelvic visceral nerves which are inhibitory to the vesical sphincter. The hypogastric nerves which are derived from the sympathetic cause contraction of the vesical sphincter in some animals and relaxation in others. The central control of the bladder is in the lumbo-sacral cord.

Benzyl benzoate acts directly on smooth muscle as shown by Macht (2). It has no known action on the bladder through the sympathetic or pelvic visceral nerves. The outstanding action on the bladder is the lowering of the sphincter tone. Normally, the tone of the sphincter varies greatly in the rabbit. In these animals it varies from about 3 to 30 cm. water pressure. If the sphincter tone varies similarly in man, individuals with a high sphincter tonus are more apt to have urinary retention following the administration of morphine. If an animal does poorly during an experiment for any reason the sphincter tone is rapidly lowered and falls to zero when the animal is dying. One can thus tell the condition of the rabbit by the sphincter tone.

Benzyl benzoate does not produce nausea or vomiting but in cases where anything taken by mouth is vomited the drug may be administered subcutaneously.

In an earlier article (3) a few cases of bladder distention and after-pains, relieved by benzyl benzoate were reported. Since that time a larger number of cases of bladder distention due to a wider range of causes have been successfully treated with this drug at the Peter Bent Brigham Hospital. There have been a few unsuccessful cases in the past but these, I believe, have been due to a lack of understanding of the proper method of procedure in treating bladder distention with benzyl benzoate.

It is, therefore, well to include here the method of using this drug in bladder distention whether this be postoperative, post-partem or reflex. Bladder distention may occur during the course of any disease, especially if the patient be bedridden. In the first place, fluids must be given in some manner to raise the intravesical tension. Three to six hundred cubic centimeters of urine in the bladder are usually required to raise this tension sufficiently so that when the tone of the sphincter is lowered by the benzyl benzoate, the intravesical tension will be sufficient to overcome the lessened tone of the sphincter and the patient will then be able to micturate. Micturition will also be aided by the voluntary efforts of the patient which raise intravesical tension and help force out the urine. Rupture of the bladder is not to be feared. Patients may be allowed to go until the bladder con-

tains 1500 cc. of urine but as a rule the bladder is not allowed to become so distended.

It is really surprising how small is the discomfort produced by a markedly distended bladder in most cases and the habit of rushing for a catheter a few hours post-operative or a few hours after a patient has not voided should be abandoned not only on account of the danger of infection but also because the discomfort is often due to causes other than bladder distention. This is well shown when the amount of the catheterized specimen amounts to 100 to 250 cc. of urine, which is not enough in itself to produce any discomfort except in an hysterectomy. A case that occurred recently illustrates this very well. Mrs. C. a few hours post-operative, complained of a good deal of "pain in the stomach" and was nauseated and vomited several times. The patient had not taken any fluids. At the usual time after operation the patient was catheterized, benzyl benzoate having failed to act. About 200 cc. of urine were obtained, not enough to produce any discomfort. This did not relieve the patient and she was still uncomfortable on the following day when she voided normally. The discomfort in this case was not due to bladder distention and it was unnecessary to catheterize the patient, although it has been taught for years that after so many hours if the patient has not voided he should be catheterized (whether he needs to be or not). There are cases, of course, where marked discomfort is produced by a distended bladder but one will find in these, 500 to 1000 cc. of urine, sometimes more. As mentioned before, after an hysterectomy or an operation in close proximity to the bladder, small amounts of urine in the bladder may produce discomfort.

One can tell roughly the amount of fluid in the bladder by palpation and percussion and by the amount of fluids the patient has been taking. When one finds the bladder distended 2 cc. of the 20 per cent alcoholic solution of benzyl benzoate are given in water by mouth.

SUMMARY

1. The normal intravesical pressure and sphincter tone varies greatly in rabbits.

2. The administration of morphine to rabbits is followed by a marked increase in the sphincter tonus.

3. Benzyl benzoate lowers the sphincter tone both in normal rabbits and in those with an increased tonus due to the previous administration of morphine.

4. These experimental findings are consistent with the clinical observations of bladder distention relieved by benzyl benzoate, in cases which have or have not had therapeutic doses of morphine.

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PRESSURE USED IN PYELOGRAPHY AND ITS EFFECTS UPON THE KIDNEY¹

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Almost from the beginning of the use of opaque pyelographic media, the dangers of pyelography have been recognized and frequently discussed. Cases of deaths following the injection of some of the opaque media into the kidney have been reported. Especially is this true of insoluble media such as the various colloidal silver preparations but this unfortunate sequel is not alone confined to this class, for even some of the soluble preparations have resulted in death after pyelography.

There has been a progressive and rapid evolution in this branch of urologic diagnosis until now we are familiar with the use of non-toxic soluble salts which give very satisfactory pyelographic shadows. At present, solutions of sodium bromide and sodium iodide are generally adopted as safest and most practical.

The observations which we wish to record herein are based on experience gained during the past three years with the use of sodium bromide as the opaque medium.

Early in the use of this solution, there were found certain recent pathological changes in our patients' kidneys which had been injected with the solution for pyelographic purposes. These kidneys had presented other pathological conditions for the treatment of which, nephrectomy had been performed. Grossly, these changes appeared as small, discrete hemorrhages into the

¹ From the Crowell Clinic of Urology and Dermatology, Charlotte, N. C. This preliminary work and pressure gauge adapter was first presented before the Mecklenburg County North Carolina Medical Society April 18, 1922.

mucous membrane of the kidney pelvis and calyces. It was observed that the color of these punctuate hemorrhages varied with the interval elapsing between the injection of the kidney pelvis and the nephrectomy. In a kidney removed two days after pyelography, these hemorrhagic spots were deep red in color but when the interval happened to be six to ten days they were brownish-red and showed a brownish-yellow discoloration of the mucosa between the spots or at their borders.

Microscopically these were seen to be small rents in the epithelium at the site of the spots with a considerable extravasation of blood under the epithelium at these points. Deeper in the mucosa there were numerous small hemorrhages. Along the collecting tubules of the pyramids small extravasations were numerous and occasionally these were found as far peripherally as the capsule itself. Furthermore, the glomeruli and network of capillaries along the collecting tubules showed a definite congestion.

These findings were found to be present so constantly that it was promptly decided that these were the results of the injection of the kidney pelvis due either to the pressure exerted in filling the pelvis or to the action of the solution itself. An examination of some kidneys removed some time previously when thorium nitrate was in vogue, showed a very similar condition and we came to believe that this action on the mucosa was not characteristic of sodium bromide.

Shortly after these observations were made, we were able to make a satisfactory determination of the 'phthalein excretion of each kidney in a patient both before and after the use of sodium bromide in securing a double pyelogram. These determinations were carefully controlled, that is, both ureteral catheters were passed readily and both fit the ureters snugly since the urine came away freely from both and after the interval during which the dye was collected, the water in the bladder showed no trace of 'phthalein. The 'phthalein excretion of one of the kidneys was reduced after the bromide injection to one-third of what it showed just two days before. The excretion from the other

kidney was reduced to a less degree. As other opportunities of this kind presented themselves it was noted that there was frequently an alteration in the renal function as manifested by a diminished 'phthalein excretion. On the other hand, other patients showed no decrease whatever in the 'phthalein output.

The findings in one of these earlier cases which called our attention to the diminution in 'phthalein output after pyelography were as follows:

Case 1541. Male, age forty-four, merchant. September 7, 1920 in the course of a routine urological examination a differential 'phthalein excretion test was made with the following findings:

URINE BEFORE INJECTION OF DYE	APPEAR- ANCE TIME	AMOUNT OF URINE COLLECTED	DYE EXCRETED IN 15 MINUTES	DYE CONCENTRATION	
	<i>minutes</i>	<i>cc.</i>	<i>per cent</i>	<i>cc.</i>	<i>per cent</i>
Right, negative.....	4	7.5	13.5	1	1.8
Left, few pus cells, an occa- sional bacillus.....	5	7.0	6.25	1	0.89

Bladder washing contained no trace of 'phthalein at the end of the period. Following this determination a double pyelogram was obtained in which 20 per cent sodium bromide was used as the injection fluid. Two days later a second 'phthalein test was performed with the following findings:

September 9, 1920

URINE	APPEAR- ANCE TIME	AMOUNT OF URINE COLLECTED	DYE EXCRETED IN 15 MINUTES	DYE CONCENTRATION	
	<i>minutes</i>	<i>cc.</i>	<i>per cent</i>	<i>cc.</i>	<i>per cent</i>
Right, negative.....	4	7.5	5.0	1	0.67
Left, negative.....	4	6.5	4.0	1	0.61

Again the bladder washings contained no trace of 'phthalein at the end of the period. It will be noted there was a distinct reduction in the 'phthalein excretion from both kidneys most marked on the right side in which the 'phthalein excretion was reduced to one-third that seen previous to the injection.

About a year and half later this patient gave us an opportunity to make a third determination which resulted as follows:

April 4, 1922

URINE	APPEAR- ANCE TIME	AMOUNT OF URINE COLLECTED	DYE EXCRETED IN 15 MINUTES	DYE CONCENTRATION	
	<i>minutes</i>	<i>cc.</i>	<i>per cent</i>	<i>cc.</i>	<i>per cent</i>
Right, negative.....	4	7.5	17.0	1	2.27
Left, numerous pus cells, few bacilli.....	5	7.0	6.5	1	0.93

It is seen that the ability of the kidneys to excrete the dye has returned to the point at which it was found before the kidneys had been injected. The duration of functional impairment to a degree as illustrated by this case we do not know but believe it is relatively short. Other cases have shown a diminution in 'phthalein output immediately following pyelographic injections with a subsequent return to their normal.

This return to an equal and normal figure was seen as early as the ninth day in case 6901. This case will also illustrate the possible influence of pressure upon the human kidney's ability to excrete 'phthalein.

Case 6901. Male, age forty-eight, farmer.

April 10, 1922. Phthalein excretion test

URINE	APPEAR- ANCE TIME	AMOUNT OF URINE COLLECTED	DYE EXCRETED IN 15 MINUTES	DYE CONCENTRATION	
	<i>minutes</i>	<i>cc.</i>	<i>per cent</i>	<i>cc.</i>	<i>per cent</i>
Right, few pus cells.....	4	10.0	12.0	1	1.2
Left, few pus cells.....	4½	10.0	12.0	1	1.2

The capacity of the left pelvis was then measured with saline solution at a pressure of 50 mm. and was found to be 17 cc. Fifteen cubic centimeters of 20 per cent sodium bromide solution was then injected at a pressure of 50 mm. without the patient suffering any pain. Pyelogram showed enlargement of kidney pelvis. There was good filling of all parts of pelvis.

April 12, 1922. Phthalein excretion test

URINE	APPEAR- ANCE TIME	AMOUNT OF URINE COLLECTED	DYE EXCRETED IN 15 MINUTES	DYE CONCENTRATION	
	<i>minutes</i>	<i>cc.</i>	<i>per cent</i>	<i>cc.</i>	<i>per cent</i>
Right, pus cells numerous.....	3½	18	15	1	0.83
Left, an occasional pus cell ...	3½	15	14	1	0.93

There is no diminution in the 'phthalein excretion from either kidney. On the other hand there is an increase in the fluid output.

April 15, 1922. The capacity of the right pelvis was then measured with saline at a pressure of 50 mm.—capacity 8 cc. It was then filled with 20 per cent sodium bromide at 200—250 mm. Hg pressure using 12 cc. The patient complained of pain in the region of the right kidney which lasted for eighteen hours.

April 17, 1922. Phthalein excretion

URINE	APPEAR- ANCE TIME	URINE EXCRETED	DYE EXCRETED IN 15 MINUTES	DYE CONCENTRATION	
	<i>minutes</i>	<i>cc.</i>	<i>per cent</i>	<i>cc.</i>	<i>per cent</i>
Right, few pus cells.....	8	15	8	1	0.53
Left, few pus cells.....	4	10	14	1	1.4

It will be noted that after injection of the left kidney with a low pressure there was no decrease in the functional activity of the kidney. After the right kidney had been submitted to an injection pressure of 200 to 250 mm., there was a decrease of 50 per cent in its functional activity as indicated by the dye excretion. This greater pressure is commonly recorded when an operator, accustomed to doing pyelographic injections without measuring his pressure accurately, suddenly has the pressure gauge introduced with the dial concealed from his view.

Nine days after pyelography, another similar test in this case shows a normal and equal dye excretion although fluid output was increased as is frequently the case after injection into the kidney.

April 4, 1922. Phthalein excretion

URINE	APPEAR- ANCE TIME	URINE COLLECTED	DYE EXCRETED IN 15 MINUTES	DYE CONCENTRATION	
	<i>minutes</i>	<i>cc.</i>	<i>per cent</i>	<i>cc.</i>	<i>per cent</i>
Right, few pus cells.....	3½	26	15	1	0.58
Left, few pus cells.....	3½	27	13	1	0.48

In these cases no. 6 ureteral catheters were used throughout; each time they were passed to the kidney pelvis, urine came away freely, and there was no leakage of 'phthalein into the bladder. The technic of performing the 'phthalein test was maintained the same throughout.

It is natural for one to associate the functional impairment just mentioned with the pathological changes found in a kidney recently submitted to an injection. There may be several theories advanced as to what causes these lesions in the structure of the kidney. The hypertonicity of the bromide solution used (15 to 20 per cent) might possibly cause damage enough to the smaller blood vessels and capillaries to produce petechial hemorrhages. Sodium bromide of this strength or even in 10 per cent solution when put into the bladder for radiographic purposes is much more irritating to the patient than physiological saline solution. Also injections of 20 per cent sodium bromide solutions into the kidney pelvis are more painful than injections of saline solution.

But from the fact these hemorrhages may be found remote from the point of application of the chemical and from the evidence we have thus far obtained experimentally in rabbits, we are inclined to believe that pressure is the outstanding factor in the production of the changes noted.

In experimental animals, we have microscopic preparations showing that under ether anesthesia, when one ureter is injected with 20 per cent sodium bromide slowly and with a minimum of pressure while the other ureter is injected with the same solution under considerable pressure—around 200 mm. Hg.—the first kidney shows a normal structure except congestion of the glomeruli and the capillary network of the pyramids, while the other kidney which was injected with considerable pressure will show breaks in the continuity of the epithelium of the kidney pelvis with sub-epithelial hemorrhages at these points. The collecting tubules are dilated and there are small extravasations of blood along the tubules extending to as distant a point as the cortical labyrinths. Some of the larger collecting tubules themselves are seen to be partially filled with blood. We have not seen any

definite degenerative changes in the epithelial cells suggestive of the hypertonic salt action of the solution but possibly these would be manifest if it were not that experimentally the solution was left in contact with the pelvic epithelium for only a brief period of time, fifteen to twenty minutes, and then the kidney promptly removed and placed in a fixing solution. If the kidney were left in the animal, as in the human subject, this change might be made manifest and furthermore the pin-point hemorrhages, which are much smaller in the experimental case, might develop to a size similar to those seen in the human kidneys several days after injection. Technical difficulties will hardly permit the recovery of the animal.

These findings just described are not characteristic of the hypertonic sodium bromide solution but identical results are obtained when physiological saline solution is used instead of sodium bromide. The kidney submitted to pressure by the injection of a solution into the pelvis is the one showing these acute traumatic lesions.

We have learned that a pressure of about 250 mm. Hg. is sufficient to split the pelvis of the rabbit's kidney and the tear extends up through the kidney substance. Weld (1) has shown in his experimental dogs that when the dog's kidney is injected with colloidal silver at a 250 mm. Hg. there is a sudden release of pressure, the solution leaves the syringe and the animal dies in a few minutes. A radiograph of the excised kidney shows that the silver solution has broken through the kidney substance at the poles and gained entrance to the general circulation causing multiple embolism and death. Multiple embolism has been the cause of occasional deaths of patients reported in the past when colloidal silver was used and we may presume that the mechanism of its production was similar to these experimental cases.

Recently we have been introducing a pressure gauge laterally into our injection system when doing a kidney injection for radiographic or therapeutic purposes. By this means we have been able to measure accurately the amount of pressure which was put upon the syringe and it is truly surprising how little force it takes to register 200 to 250 mm. on the gauge. Any one

who is accustomed to inject kidneys without measuring his pressure accurately will register a much greater pressure than he realizes. The introduction of this device has permitted us to get away from the guess work of determining the right amount of pressure and to discard the cumbersome burette or other similar methods. We have now a simple condensation of this scheme which makes it almost as easy for the operator as if he were handling the syringe alone.

By this means we have been able to measure the pressure put on the syringe in injecting pyelographic media or other solutions and have found that with a slow injection lasting about four to five minutes at a pressure of 50 mm. Hg., we have been able to get as clear-cut a filling of the kidney pelvis as we have gotten in any other way. Furthermore, if the pelvic capacity is measured with a slow saline injection using the same pressure precautions and stopping at the first sensation that the patient feels in the region of the kidney; then following the withdrawal of the saline with the opaque medium using about 1 to 2 cc. less than the capacity, the injection can be stopped just short of the distention point and the patient is saved thereby the greater part of the suffering usually incident to a pyelographic examination. It cannot be denied, however, that pyelographic solutions of concentration enough to give a satisfactory shadow are more irritating to the mucosa of the urologic tract than physiological saline.

SUMMARY

From the pathological specimens we have obtained at operation and from the evidence we have thus far gained from animal experiment, we believe that injection of solutions into the kidney under considerable pressure is followed by certain traumatic lesions in the kidney. These lesions might become the site for the lodgment of infection and subsequent penetration of the infection into the deeper structures of the kidney. They may possibly serve as nuclei for stone formation.

In some patients submitted to kidney injections there is a striking diminution of the 'phthalein excretion following this

procedure. This finding adds weight to the present prevalent opinion that injection of both kidneys simultaneously is unwise. Apparently, this diminution is only transient unless the pressure is unduly great and actually causes an extensive split of the kidney substance.

Satisfactory filling of the kidney pelvis for either therapeutic or radiographic purposes may be obtained by a slow injection at 50 mm. Hg. pressure or less.

The patient suffers less pain from the treatment of the kidney and the mechanical damage to the kidney is less when the pressure put on the kidney is low.

A special gauge adapter is presented with which it is easy for the urologist to inject solutions into the ureteral catheter, while at the same time the pressure can always be under his control.

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- (1) WELD, E. H.: Renal absorption with particular reference to pyelographic media. *Medical Clinics of North America*, iii, 728, November, 1919.

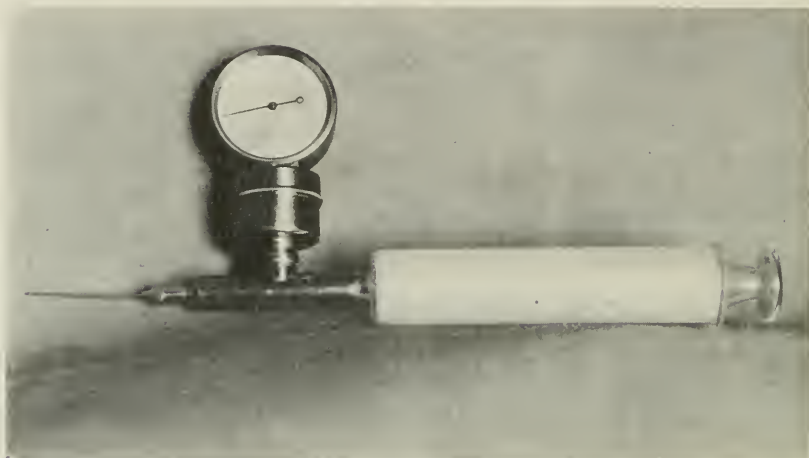


FIG. 1. PRESSURE GAUGE ADAPTER FOR MEASURING PRESSURE UNDER WHICH SOLUTIONS ARE INJECTED INTO THE KIDNEY (ASSEMBLED)

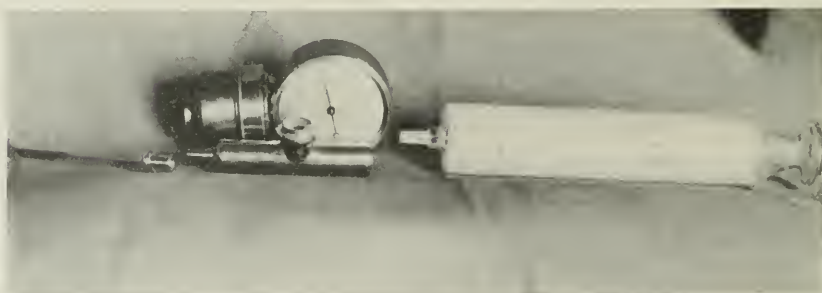


FIG. 2. SAME AS FIGURE 1, SEPARATED INTO ITS PARTS

AN EXPERIMENTAL STUDY OF THE URETER AFTER NEPHRECTOMY

REPORT OF A CLINICAL CASE OF PYO-URETER¹

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This study was undertaken in order to investigate the ultimate fate of the ureter after nephrectomy. Experiments were planned to simulate, as closely as possible, the conditions found in clinical cases in which nephrectomy is performed, and either a normal ureter, a hydro-ureter, or a pyo-ureter (infected hydro-ureter) is left undisturbed. A few experiments were performed leaving the normal ureter in place in order to determine the natural trend of events in the healthy organ after nephrectomy and to have a basis of comparison for the diseased ureters. It was believed that the experiments with hydro-ureters, infected and uninfected, might have some clinical importance, as such ureters are constantly being left in the body after nephrectomy. For example, ureteral calculus often produces hydro-ureter and hydro-nephrosis, but probably rarely causes complete blocking of the ureteral contents and permits drainage of the ureter after nephrectomy. Complete blockage of ureteral contents occurs following ligature of the ureter with silk during operations, such as resection of the bladder and colon for cancer and may accidentally occur with catgut in operations in the pelvis. A certain percentage of such tied-off kidneys produce acute surgical conditions necessitating removal of the organ, especially if it was the site of infection before ligation. The ureter in such cases is always

¹ Abridgment of thesis submitted to the Faculty of the Graduate School of the University of Minnesota in partial fulfillment of the requirements for the degree of Master of Science in Urology, January, 1922.

slightly enlarged and full of fluid which will never have an opportunity to escape naturally.

In order to produce the hydro-ureters it was necessary to obstruct the outflow of urine from one kidney and cause hydro-nephrosis; thus considerable data was secured which simply confirmed the work of others in regard to this process. The effect on the kidney of complete obstruction of the ureter has been studied and full corroboratory accounts of such work have been published by Barney, Keith and Pulford, Reid, Johnson, Caulk, Harrington and others. This phase of the subject will not, therefore, be discussed.

Experimental work on the ureter has been confined mainly to ligation and its effect on the kidney, and to transplantations. Caulk's work was undertaken primarily to establish the length of time a kidney could be obstructed completely and still resume function and to determine the length of time necessary for the absorption of the plain catgut causing the obstruction and the length of time before the lumen of the ureter reopened. It was shown that the catgut was absorbed in about three weeks and the lumen of the ureter was open in from six to eight weeks sufficiently to drain the urine freely. The kidney, meanwhile, unless nephrostomized, would be past the point of maintaining function. Johnson had previously demonstrated that if obstruction had not lasted more than two weeks, function might possibly return to normal and the longer the period of obstruction, the slower the rate of recovery.

Dogs were used in all the experiments because of the similarity of the anatomy, the physiology, and the blood supply to that of man. Surgical procedures were carried out with the strictest observance of aseptic technic. The operative area was prepared by shaving, thorough cleansing with benzene and alcohol and two coats of iodine (10 per cent). The animals were anesthetized with ether. The technic of the various surgical procedures is discussed briefly under each group of experiments; the peritoneum and fascia were closed with catgut and the skin closed with linen and a protective dressing and sealed with collodion. The animals were kept under conditions most favorable for health and

comfort. The material studied has been classified in three groups:

Group 1. Nephrectomy; a normal ureter remaining.

Group 2. Nephrectomy; a hydro-ureter or pyo-ureter, with (a) a patent lumen, or (b) a completely obstructed lumen remaining.

Group 3. Control Group; a hydro-ureter or pyo-ureter produced without nephrectomy, but with (a) ureteral obstruction removed, or (b) ureteral obstruction not removed.

Group 1. Left nephrectomies were performed on three dogs and they were allowed to live as long as possible (Table 1). In

TABLE 1
Group 1. Normal ureter after nephrectomy

EXPERI- MENT 1919	NE- PHREC- TOMY	DURA- TION OF EXPERI- MENT	NECROPSY FINDINGS
		<i>days</i>	
671	10-7	480	Right kidney enlarged almost one-third more than normal; right ureter normal. Left ureter apparently normal, catheter passed equally as well as in the right ureter. Necropsy 54, (1921)
674	10-7	275	Right kidney and ureter normal. Left ureter thinner walled than the right and without the "feel" of normal tissue as in the right. Lumen patent. Necropsy 331, (1920)
677	10-9	405	Right kidney somewhat enlarged, right ureter normal. Left ureter smaller than the right with patent lumen. Necropsy 593, (1920.)

each case at necropsy the ureter, which had been deprived of its normal function of conveying urine, was found patent and in two instances noticeably smaller than its mate. Sections from the same level of both ureters were studied microscopically. It was impossible to detect any difference in the mucosa of the right and left ureters or in the fibrous coats. However, a comparison of the muscular layers revealed a definite diminution of the amount of muscular tissue in the functionless ureters (Figs. 1 and 2). From these observations it may be deduced that no attempt is made toward obliteration of the lumen of the normal ureter after nephrectomy but that the muscular coat becomes atrophied.

Group 2. One ureter was ligated in each of twelve dogs at a point 2.5 cm. above the bladder with catgut (chromic no. 2) applied so as to facilitate removal later. It was found that if a small section of a small urethral catheter was split and placed around the ureter with the ligature tightened over it, later removal was much easier than if the ligature was applied directly to the ureter. In about two weeks the ligature around the ureter was carefully removed, the condition of the ureter noted, and the kidney on that side excised. The object of this series of experiments was to produce in each case a ureter such as would be present in hydronephrosis or pyonephrosis due to obstruction



FIG. 1

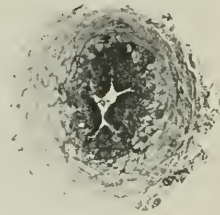


FIG. 2

FIG. 1. EXPERIMENT 671. NORMAL RIGHT URETER. $\times 14$

FIG. 2. EXPERIMENT 671. LEFT URETER, SHOWING MUSCULAR ATROPHY AND NORMAL MUCOUS MEMBRANE. $\times 14$

low in the ureter and, if possible, to produce a ureter that would drain following removal of the obstruction. In performing the nephrectomy, the upper ureter was ligated twice with silk and severed between the ligatures, so that its contents would not be lost. In four of the experiments pure cultures of staphylococci were introduced into the distended ureter.

At necropsy in six of these animals (Table 2), it was found that the ureteral obstruction had either been relieved at the time the ligature was removed or that the lumen had opened subsequently, as the ureters were empty and it was possible to demonstrate a lumen at the point of ligation. In only one animal, however,

TABLE 2

Hydro-ureter, with drainage of contents, at various periods after nephrectomy

EXPERIMENT 1919	URETER LIGATED	LIGATURE REMOVED AND NEPHRECTOMY	CONDITION OF URETER AND KIDNEY	DURATION OF EXPERIMENT	NECROPSY FINDINGS
				<i>days</i>	
695	10-14	10-30	Tortuous hydro-ureter above ligature, normal below. Hydro-nephrosis	60	Necropsy 617. Right kidney and ureter below ligation normal. Left ureter above ligation, enlarged and cord-like. Lumen open to fluid
713	10-21	11-6	Tortuous hydro-ureter above ligature, normal below. Hydro-nephrosis	315	Necropsy 445. Slight hypertrophy of the left kidney. Left ureter normal. Right ureter slightly larger above ligation than below. Lumen patent
694	10-14	10-30	Tortuous hydro-ureter above ligature, normal below. Hydro-nephrosis	65	Necropsy 627. Right kidney and ureter normal. Left ureter cord-like and slightly larger above ligation than below
782	10-18	12-2	Very large tortuous hydro-ureter. Large hydronephrosis	239	Necropsy 339. Right kidney and ureter normal. Left ureter apparently normal. Lumen patent and free of any obstruction
700	10-16	11-6	Large hydro-ureter and hydronephrosis	167	Necropsy 145. Right kidney, acute nephritis; right ureter normal. Left ureter enlarged above ligation, normal below. Lumen obstructed but patent
714	10-21	11-4	Large hydro-ureter and hydronephrosis. Culture of staphylococcus introduced into distended ureter	87	Necropsy 19 (1920). Right kidney and ureter normal. Left ureter almost twice size of right, but lumen patent

was the ureter normal in size throughout. In the other five animals there was a varying degree of obstruction with reduction in the size of the lumen which allowed the passage of fluid but denied, in some cases, the passage of a ureteral catheter. These cases might be compared to surgical cases in which a hydro-

nephrotic kidney was removed, secondary to a stone in the ureter, leaving a hydro-ureter with a calculus in its lower portion which did not cause complete obstruction.

In the five animals the size of the ureter above the point of ligation was from two to three times that of its mate and hypertrophy of the ureter, as a whole, could be made out grossly, while below the point of ligation the ureters were normal. On microscopic examination the increase in the size of the ureteral



FIG. 3



FIG. 4

FIG. 3. EXPERIMENT 695. NORMAL RIGHT URETER. $\times 14$

FIG. 4. EXPERIMENT 695. LEFT URETER, SHOWING NORMAL MUCOSA AND HYPERTROPHIC MUSCULATURE. $\times 14$

wall was found to be owing to actual increase in the amount of muscular tissue, the increase being chiefly confined to the circular layer but also demonstrable in the longitudinal layers. That there was an actual increase in muscle tissue could be appreciated by comparing the thickness of the muscle layer in the diseased ureter with that of its mate and by taking into consideration the increased size of the one over the other. For example, in Experiment 695, the thickness of the muscle wall of the left ureter is greater than that of the right and the diameter of the left ureter is several times that of the right (Figs. 3 and 4).

The greatest amount of hypertrophy or increase in muscular tissue, as compared with its mate, was observed in the animals coming to necropsy after the shorter periods and was less pronounced in those that lived longer, as in Experiments 713 and 782. This indicates that after the obstruction is removed which provides the stimulus to muscular hypertrophy, the muscular coat gradually atrophies. This had evidently occurred in Experiment 782 in which obstruction to the lumen could not be demonstrated; the two ureters were apparently the same size although still showing microscopically a slight increase of muscle tissue in the ureter that had been obstructed.

Except for the "ironing out" of the mucosal folds to a varying degree in each instance, the mucous membrane appeared normal. There was no demonstrable change in the fibrous coat and none in the submucosa, except in one case (Experiment 713) in which there was lymphocytic infiltration and slight connective tissue formation. In no case was there peri-urethral inflammation either active or old as would be indicated by adhesions. The staphylococci introduced into the ureteral contents in the one case had evidently drained out with the fluid and did not cause inflammation. These findings indicate that a hypertrophic hydro-ureter with incomplete obstruction to its lumen will, after nephrectomy, empty itself and gradually become atrophic in the muscular layer. It will preserve a normal mucous membrane and will not cause irritation outside its walls.

The ureters of the remaining six animals (Table 3) were all completely obstructed at the point of ligation, thus approximating the surgical cases of complete obstruction to a hydro-ureter or pyo-ureter after nephrectomy. All of the ureters were distended, three with clear fluid and three with pus. Those containing pus were surrounded by adhesions and it was difficult to remove them from their beds. In one case the pus had ruptured through and caused an abscess. The ureters were enlarged above the point of constriction from three to five times the size of their mates and were normal below that point.

Microscopic examination revealed flattened mucosa, even to complete obliteration of the mucosal folds; it was otherwise

TABLE 3

Hydro-ureter and pyo-ureter, with complete obstruction to drainage of contents at various periods after nephrectomy

EXPERIMENT 1919	URETER LIGATED	LIGATURE REMOVED; NEPHRECTOMY	CONDITION OF URETER AND KIDNEY	DURATION OF EX- PERIMENT	NECROPSY FINDINGS
				<i>days</i>	
598	10-16	11-20	Large tortuous hydro-ureter. Large hydro-nephrosis	375	Necropsy 549 (1920). Right kidney one-third larger than normal, ureter normal. Large dilated left ureter tortuous and full of pus. Complete obstruction at point of ligation, normal below. Ureter surrounded by dense adhesions
732	10-28	11-12	Hydro-ureter and hydronephrosis. Culture of staphylococci introduced into ureter	28	Necropsy 567. Right kidney and ureter normal. Left ureter distended with pus. Abscess around lower ureter
717	10-23	11-11	Large hydro-ureter and hydronephrosis	46	Necropsy 717. Right kidney and ureter normal. Left ureter twice the size of the right and full of clear fluid. Complete stenosis of lumen
734	10-28	11-12	Tortuous hydro-ureter and hydronephrosis	35	Necropsy 589. Right kidney and ureter normal. Left kidney distended with clear fluid as at previous operation. Complete stenosis of lumen
733	10-28	11-12	Large hydro-ureter	106	Necropsy 70 (1920). Right kidney and ureter normal. Left ureter about four times normal size and distended with clear fluid. Complete stenosis of lumen
699	10-16	11-4	Large hydro-ureter and hydronephrosis. Culture of staphylococci introduced into ureter	357	Necropsy 512 (1920). Right kidney showed chronic nephritis; right ureter normal. Left ureter large, hard, contained turbid fluid, and was surrounded by firm adhesions. Complete obstruction

normal. The submucosa was normal in the uninfected cases but in the infected cases showed lymphocytic and leucocytic infiltration, which in one instance extended into the muscular layer. The muscular layer was markedly increased in all and more increase of the longitudinal muscles was noted than in the previous ureters examined (Figs. 5 and 6). Increase in longitudinal muscle was noted especially in the ureters of animals that lived longest, (Experiments 598 and 699) although the circular coat still predominated. This may indicate that hypertrophy occurs first in the circular layers and later in the longitudinal.

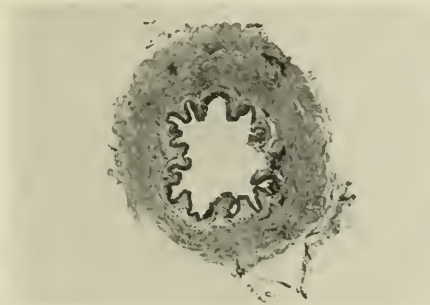


FIG. 5. EXPERIMENT 598. NORMAL RIGHT URETER. $\times 14$

In all of the cases the muscular hypertrophy was more pronounced than in the group in which the ureter had drained, indicating that the muscle increased somewhat after nephrectomy and did not atrophy as long as the ureter contained fluid.

The most striking feature at necropsy in these cases was the distension of the ureter with fluid. The three uninfected hydro-ureters were apparently in the same condition as when ligated and dropped back after nephrectomy. The three infected hydro-ureters, two of which had been deliberately infected at the time of nephrectomy, showed definite inflammatory reaction with infiltration of leucocytes into the submucosa and outer fibrous coat (Fig. 6), and the formation of connective tissue adhesions around the ureter. In one instance the organisms penetrated the walls of the ureter and a peri-ureteral abscess resulted.

From these results it would seem that after nephrectomy in cases of hydro-ureter and pyo-ureter in which there is complete obstruction, absorption, if occurring at all, would be very slow and with the additional danger, in the infected cases, of the infection extending through the ureter. In this group, also, the mucous membrane remained intact but the muscular coat remained hypertrophic.



FIG. 6. EXPERIMENT 598. LEFT URETER SHOWING MUSCULAR HYPERTROPHY, NORMAL MUCOSA, AND PERI-URETERITIS. $\times 14$

Group 3. The ureter was ligated in nine animals but nephrectomy was not performed later. The obstruction to the ureter was successfully removed in two cases, not attempted in four, and failed to be removed in three. These experiments were performed for the purpose of establishing controls on the results obtained in Group 2.

In the two instances in which hydro-ureter and hydronephrosis were produced and the obstruction to the ureter removed fourteen days later, without nephrectomy, the animals lived for a long

TABLE 4
Hydro-ureter, with free drainage and without nephrectomy

EXPERIMENT 1919	URETER LIGATED	LIGATURE REMOVED	CONDITION OF OPERATED URETER AND KIDNEY	DURATION OF EXPERIMENT	NECROPSY FINDINGS
693	10-14	10-28	Large hydro-ureter. Hydronephrosis	<i>days</i> 325	Necropsy 444 (1920). Right kidney slightly enlarged, ureter normal. Left kidney smaller than normal; slightly hydro-nephrotic. Left ureter thickened and enlarged at point of ligation, slightly enlarged above and normal below. Lumen at point of ligation very small but patent
712	10-21	11-4	Ureter dilated and tortuous. Hydronephrosis	340	Necropsy 490 (1920). Right kidney and ureter normal. Left kidney but slightly smaller than the right and, on cut section, presented no gross difference from the right aside from a slight enlargement of the pelvis. Left ureter slightly larger than right, except at point of ligation where it was definitely thicker. It was impossible to pass a ureteral catheter either up or down the ureter past this point but fluid passed through without difficulty. Judging from gross appearance the kidneys had equal function

time (Table 4) and the results were sufficiently interesting to record. The period of obstruction was the same in each instance and presumably the amount of damage to the kidney the same.

In each instance, after the removal of the obstruction, the kidney resumed function and the degree of recovery was evidently affected by the condition of the ureter, as in one case there was partial obstruction of the lumen and in the other an unobstructed channel. As the result of the partial obstruction in Experiment 693 (Table 4) the ureter was hypertrophic and there was slight hydronephrosis with some atrophy of the substance of the kidney. Microscopic examination of the effected kidney showed normal glomeruli and tubules and also areas of intertubular connective tissue formation, while the muscular coat of a hypertrophic ureter was developed at least one-third more than that of its mate. In Experiment 712 (Fig. 7) the ureteral lumen was unobstructed, and it was difficult to determine, grossly or microscopically a difference in the substance of the kidneys, but the lumen of the left ureter was slightly larger than that of the right, although the muscle coats were equally developed. These results were interesting in that they confirmed previous reports of the return of renal function, providing damage by obstruction to the outflow of urine is not irreparable. From the condition of the ureters it seems that muscular hypertrophy produced by obstruction tends to disappear after the obstruction is removed.

The remaining seven experiments in Group 3 without later nephrectomy consisted of one in which the ureter was ligated at a point 5 cm. below the pelvis of the kidney, two in which one ureter was crushed and ligated at a point just above the bladder, and four in which the attempt to remove the ligature, previously placed on the ureter, failed (Table 5). The hypertrophy of which the muscular wall of the ureter is capable is illustrated by these experiments (Fig. 8) as in all but one animal that lived only seventeen days the ureter was dilated and tortuous and greater increase of the muscle layer was found than in ureters previously examined. In this group also the animals that lived the longest had a greater increase in the longitudinal muscle bands although the circular layer always predominated. In no case, however, was this hypertrophy equal to the hypertrophy of the ureter usually observed in cases of ureteral obstruction with a functioning kidney. The results in Experiment 678, in which the ureter was ligated at a

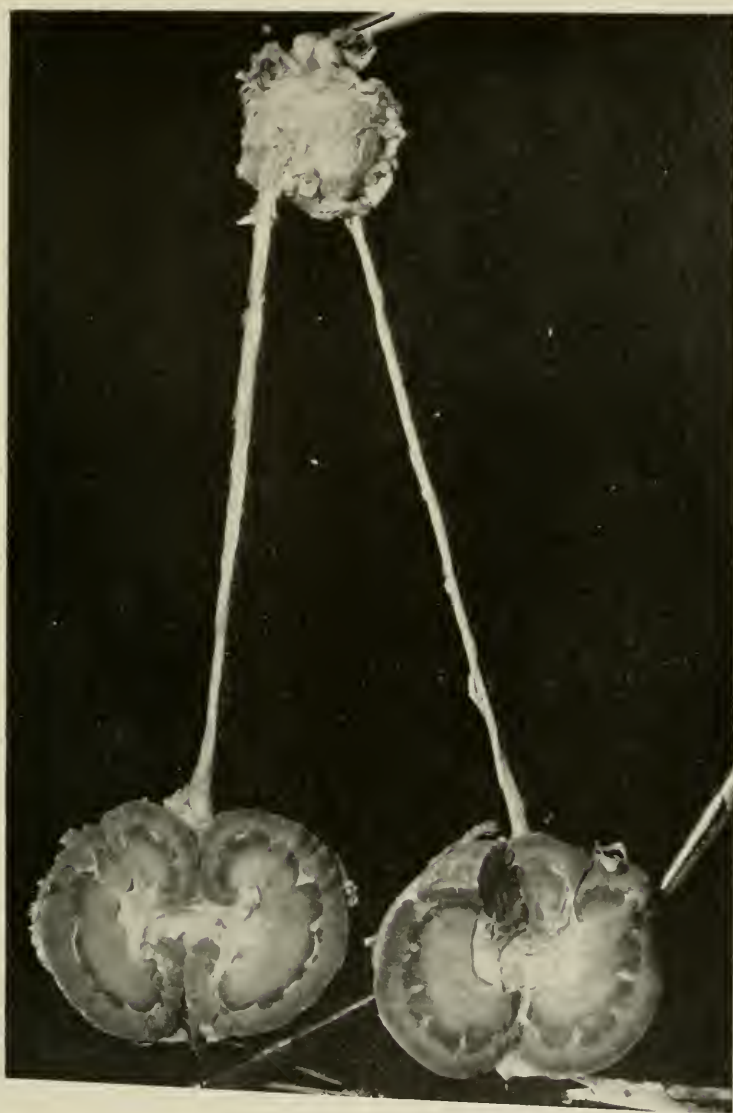


FIG. 7. EXPERIMENT 712. KIDNEYS, URETERS AND BLADDER

TABLE 5

Hydro-ureter and pyo-ureter with complete obstruction to drainage of contents and without nephrectomy

EXPERIMENT 1919	URETER LIGATED	LIGATURE NOT REMOVED OR FAILED TO BE REMOVED	CONDITION OF URETER AND KIDNEY OPERATED ON	DURATION OF EXPERIMENT	NECROPSY FINDINGS
				days	
672	10-7		Ureter crushed and ligated	72	Necropsy 626. Right kidney and ureter normal. Left kidney a large hydronephrotic sac. Left ureter tortuous and dilated above ligation, normal below
701	10-16		Ureter crushed and ligated	17	Necropsy 494. Right kidney and ureter normal. Large hydronephrosis of left kidney which had ruptured into the perirenal fascia where there was a large collection of urine. Left ureter dilated above point of ligation, normal below
678	10-9		Ureter ligated 5 cm. below pelvis of kidney. No attempt to remove it	480	Necropsy 34 (1920). Right kidney slightly enlarged with normal ureter. Left kidney and its pelvis formed a large sac measuring 8 by 12 by 16 cm. and filled with clear fluid. Left ureter from sac to point of ligation was very tortuous and measured 12.5 cm. Left ureter normal below the point of ligation
781	11-18	12-2	Unable to remove the ligature. Hydronephrosis and hydro-ureter. Religated ureter	93	Necropsy 82 (1920). Right kidney and ureter normal. Left kidney a shell slightly smaller than right kidney and filled with pus. Left ureter 1 cm. in diameter and filled with pus. Abscess around the lower portion of the ureter

TABLE 5—Continued

EXPERIMENT 1919	URETER LIGATED	LIGATURE NOT REMOVED OR FAILED TO BE REMOVED	CONDITION OF URETER AND KIDNEY OPERATED ON	DURATION OF EXPERIMENT	NECROPSY FINDINGS
				<i>days</i>	
718	10-23	11-11	Ureter three times normal size. Hydronephrosis. Unable to remove ligature; re-ligated and dropped back	360	Necropsy 525 (1920). Right kidney and ureter normal. Left kidney was one-half the size of the right, with a thin cortex of renal tissue and full of cloudy fluid. Both kidney and ureter were matted in adhesions. Left ureter enlarged and tortuous to point of ligation, normal below. Impossible to demonstrate lumen at point of ligation. Condition evidently infected hydronephrosis with perinephritic infection and partial absorption of the contents of the kidney
780	11-18	12-2	Hydro-ureter and hydronephrosis. Ligature could not be removed; ureter re-ligated and returned	310	Necropsy 489 (1920). Right kidney and ureter normal. Large uninfected hydronephrosis on left with large dilated ureter
679	10-8	10-23	Large tortuous hydro-ureter and large hydronephrosis. Ligature could not be removed	180	Necropsy 155 (1920). Right kidney and ureter normal. Large infected hydronephrosis on left with a large ureter also full of pus. Marked perinephritic infection

point 5 cm. below the pelvis of the kidney, were very interesting in that the ureter was normal below the point of ligation and did not show atrophic tendencies, but was greatly hypertrophic above the point of ligation (Figs. 9, 10, 11, and 12). The mucous membrane, except for the obliteration of the mucosal folds by the



FIG. 8. EXPERIMENT 679. SECTION OF WALL OF LEFT URETER, SHOWING MUSCULAR HYPERTROPHY. $\times 14$

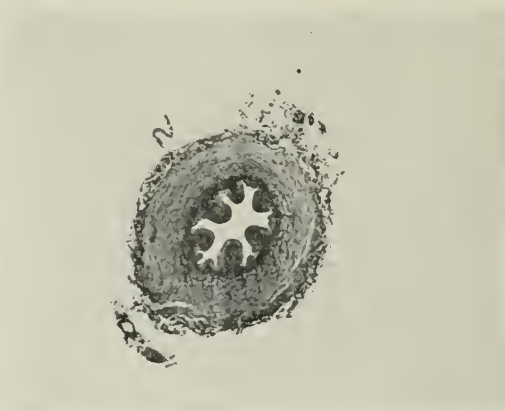


FIG. 9. EXPERIMENT 678. NORMAL RIGHT URETER. $\times 14$

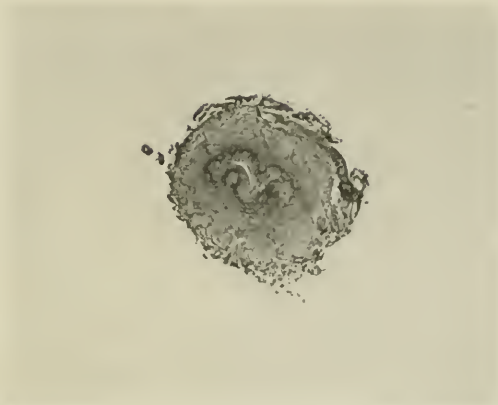


FIG. 10. EXPERIMENT 678. LEFT URETER BELOW POINT OF COMPLETE OBSTRUCTION, SHOWING NORMAL MUCOSA AND MUSCULATURE. $\times 14$

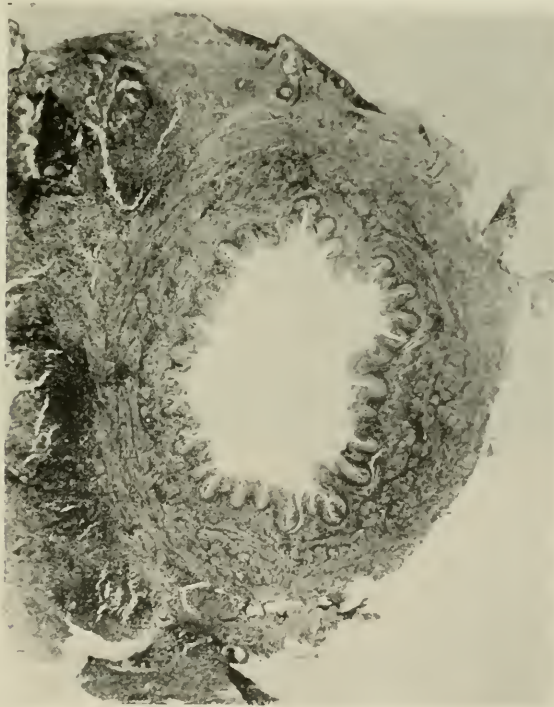


FIG. 11. EXPERIMENT 678. LEFT URETER ABOVE POINT OF COMPLETE OBSTRUCTION, SHOWING NORMAL MUCOSA AND MARKED HYPERTROPHY OF THE MUSCLE LAYERS. $\times 14$

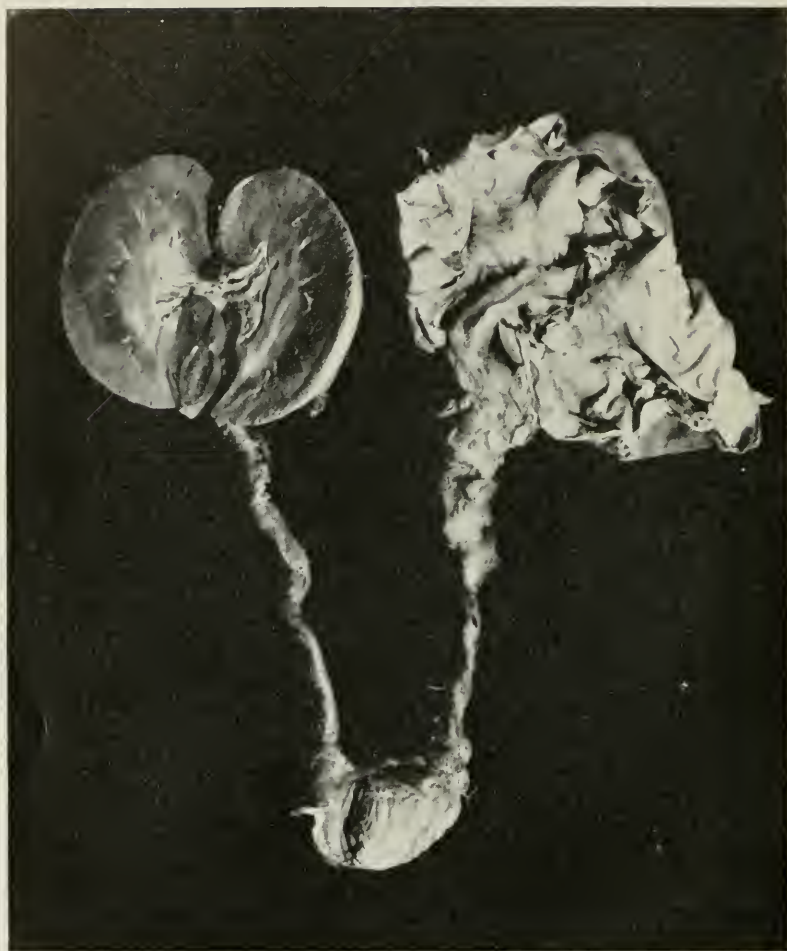


FIG. 12. EXPERIMENT 678. RIGHT KIDNEY, LEFT HYDRONEPHROTIC SAC, BOTH URETERS AND BLADDER

distension of the ureter, was normal in every case, including those that were infected.

Besides the experiments tabulated there were four in each of which one ureter was ligated. One of the animals died on the eighth day from a badly infected wound, two on the twenty-

seventh and thirtieth days respectively from distemper and pneumonia, and one on the fourteenth day from the anesthetic, while preparations were being made to remove the ligature around the ureter. All of these showed the usual hydronephrosis and hydro-ureter.

REPORT OF A CLINICAL CASE OF PYO-URETER

That a diseased ureter can cause later complications after nephrectomy has been recognized by urologists, although reports of cases seem to be difficult to obtain. Fowler reported a case of pyo-ureter after nephrectomy due to calculus in the ureter and referred to Israel as having reported four cases of "empyema of the ureter" as a complication in 900 nephrectomies. Fowler's case was particularly interesting in that he observed the intermittent expulsion of thick pus from the ureteral meatus, thus establishing the fact that the ureter is capable of peristaltic contraction after nephrectomy. To these reported cases can be added another from the records of the last three years of the Mayo Clinic, in which the ureter required removal after nephrectomy.

Case A312821. Mrs. H. L., aged thirty-seven years, registered in the Mayo Clinic April 10, 1920. She gave a history of successful removal of a stone from the left kidney in 1915, with relief of symptoms for one year, when she had recurring attacks of renal colic which have persisted. A roentgenogram of the left kidney area showed several shadows and cystoscopic examination revealed a large infected hydronephrosis with a functionless kidney. Nephrectomy was performed April 26, 1920; an uneventful convalescence followed. On April 5, 1921, the patient returned complaining that for the last two months there had been swelling and soreness in the region of the wound. A roentgenogram of the left renal area revealed a shadow, 2 by 3 cm., opposite the third lumbar vertebra and a lead catheter, introduced at cystoscopic examination impinging against this shadow. There was no secretion from the left orifice. Diagnosis was made of stone in the left ureter, ureteritis, and abscess formation. At operation, April 11, 1921, the ureter was found distended with pus above a point completely blocked by a calculus and there was marked periureteral inflammation. About 8 cm. of the

ureter, to a point below the obstruction, was removed. The patient was discharged April 30 with a healed wound.

Surgical intervention for pyo-ureter after nephrectomy is rarely required and usually the condition is due to stone in the ureter which prevents escape of the ureteral contents. The fact that the ureteral lumen is seldom so completely blocked by a calculus that the ureteral contents cannot gradually escape would account for the smaller number of cases reported. However, when the lower ureter is ligated with silk, as in resections of the bladder, and nephrectomy is required later, the possibility of pyo-ureter developing should be considered. This fact had been recognized by Hunt, of the Mayo Clinic, who, while removing a kidney in which an acute septic condition had developed following ligation of the lower ureter with silk, provided for drainage of the ureter by insertion of a catheter into the ureter, bringing it out through the wound.

DISCUSSION

The experimental results obtained in the hydro-ureters and pyo-ureters depended entirely on whether or not the ureteral contents were evacuated. When drainage occurred the distended ureter became smaller, through collapse of the lumen and atrophy of the muscle coat, and peri-ureteral inflammation did not occur. When obstruction to drainage was present, the muscular hypertrophy remained and absorption of the ureteral contents seemed very limited if occurring at all. Infection of the ureteral contents, if not present at the time of nephrectomy, occurred later in some instances and always spread through the ureteral wall to cause peri-ureteritis. Peri-ureteritis was present in every pyo-ureter in some degree varying from inflammatory adhesions to abscess formation. This would indicate that drainage of the ureteral contents should be provided for at the time nephrectomy is performed, if there is known or doubtful complete obstruction to such drainage into the bladder.

Atrophy of the muscular wall of the normal ureter after nephrectomy was a finding which was to be expected as it simply

represents the atrophy of disuse from the lack of any stimulus to ureteral contraction. Likewise, the gradual atrophy of the hypertrophic muscle, which had developed in the attempt to overcome the obstruction to the outflow of the ureteral contents, would seem a natural occurrence after the obstruction had been removed and the ureteral contents drained.

The greater muscular hypertrophy found at long periods after nephrectomy in the walls of the ureters with complete obstruction to the evacuation of their contents would indicate that such hypertrophy increased after nephrectomy. This would seem to be logical, providing the blood and possibly the nerve supply of the ureter were not interfered with, as the stimuli to uteral peristalsis are present as long as the ureter is distended with fluid contents. Such must have been the condition in the case reported by Fowler; he observed, more than three years after nephrectomy, the intermittent forcing of thick pus into the bladder. This case differed from the experimental cases in that there was some escape of the ureteral content with each peristaltic wave and brings up the question whether or not peristalsis persists when the lumen is distended and there is no escape of contents on contraction. Whether or not nephrectomy was performed would not affect the persistence of peristaltic contractions of the ureter after the point had been reached when the kidney ceased secreting urine, as the ureter is not dependent on the kidney for stimulus to contraction, except as it supplies the urine. The degree of muscular hypertrophy obtained in the complete obstruction experiments of Groups 2 and 3 would seem to indicate that peristalsis continues as long as a stimulus is supplied by ureteral contents, although this hypertrophy is not equal to that usually seen in experimental work, such as the transplantation of ureters, when there is partial obstruction to the lumen of the ureter. These findings would seem to warrant the conclusion that the hypertrophic hydro-ureter or pyo-ureter, with complete obstruction to evacuation of contents, will remain hypertrophic and atrophy will not occur in its muscular wall. This conclusion was substantiated by study of the walls of the ureter of the clinical case reported, as there was marked muscular hypertrophy.

The persistence of the mucous membrane in all of the experiments from the atrophic normal ureter to the large distended pyo-ureter was noteworthy. Except for the "ironing out" by distension of the normal mucosal folds the membrane was intact in every case, although, in the infected cases, it had permitted the migration of the infecting agent through to the submucosa and muscular wall.

CONCLUSIONS

1. In the normal ureter after nephrectomy no attempt is made toward obliteration of the lumen by disappearance or atrophy of the mucous membrane but there is a noticeable atrophy of the muscular coat.

2. Hydronephrosis developed in every case following the production of complete obstruction of the ureter, the condition progressing to complete destruction of the substance of the kidney, unless the obstruction was removed.

3. The ureter, after complete obstruction, becomes a hydro-ureter by distention of the ureteral lumen with the retained urine. Hypertrophy of the muscular layers, chiefly of the circular though also of the longitudinal layers occurs.

4. In the hypertrophic hydro-ureter or pyo-ureter, with drainage of its contents after nephrectomy, the mucous membrane remains intact and the muscular coat gradually atrophies.

5. In the hypertrophic hydro-ureter or pyo-ureter with complete obstruction to drainage of the ureteral contents after nephrectomy, the mucous membrane remains intact and the muscular coats remain hypertrophic.

6. Absorption of the contents of a distended ureter is very limited if it occurs at all.

7. If infection is present in the contents of the ureter, it may spread through the wall and give rise to peri-ureteral infection and abscess formation.

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A CASE OF BILATERAL PYELITIS DUE TO THE BACILLUS PYOCYANEUS

AN UNUSUAL KIDNEY INFECTION DIAGNOSED THROUGH URETERAL CATHETERIZATION

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The *B. pyocyaneus* as a cause of disease in the genito-urinary tract is rare; therefore a report of its occurrence is of considerable interest to the urologist. Its appearance is particularly unusual as a sole cause of pyelitis. After a careful search of the literature available, we have been able to find but fourteen cases of this nature reported, only six of which were proven by the ureteral catheter.

Compiling the causes of non-tuberculous infection in the upper urinary tract, Campbell and Rhea (1), Chute (2), David (3), Brown (4) and Lindermann (5) found 6 cases of *B. pyocyaneus* among 251. This organism may invade any of the genito-urinary organs. It has been repeatedly found in the bladder. However, in a large number of cases, it is non-pathogenic and occurs in symbiosis with organisms of many types. Among those reporting its appearance in the bladder are Bernhardt (6), Brown (7), Hübener (8), Jadkewitz (9), Grulee (40), Kleinberger (10) and McWeeney (11). It has been obtained from the ureter and kidneys through the ureteral catheter by Kleinberger (10), Heiman (12), Aschner (13), Haines (14), Cecil and Hill (15) and Campbell and Rhea (1). It was found in a case of acute epididymitis by Hirschberg (16). Perkins (17) has grown the organism from the uterus in a case of puerperal septicemia and from the testis in a case of orchitis. La Place (18) encountered this organism associated with cocci in six cases of endocervicitis. Finkelstein (19), in 1899, was the first to culti-

vate the bacillus from the blood of a patient suffering from general sepsis. Later Brill and Libman (20) cultivated the organism from the blood of a fulminating case of general sepsis. At autopsy the *B. pyocyaneus* was recovered from the kidneys.

B. pyocyaneus exists as a saprophytic organism in nature. It is found as one of the principal diamidizing agents in the soil. In man it is frequently isolated from the buccal and pharyngeal membranes, the bronchial tubes and from the skin. In these places it often occurs without pathogenic significance. It occasionally becomes pathogenic invading particularly old wounds on the skin where it forms abscesses containing green-blue pus. It also causes abscesses in the lungs and liver, mastoiditis and general sepsis.

In 1860 Fordos (21) demonstrated that the blue-green color in wounds was due to the formation of a crystallizable chemical substance which he called "La Pyocyanine." Many investigators made unsuccessful attempts to determine the cause of the production of this pigment. Later, in 1882, Gessard (22) demonstrated that it was fabricated by the *B. pyocyaneus* which he succeeded in growing in pure culture. Following Gessard's discovery, this bacillus was for some time regarded as a purely saprophytic organism incapable of producing pathological lesions either in man or in animals. Charrin (37) later studied experimental infections by the *B. pyocyaneus* in animals and established beyond a doubt its etiological relations to the production of certain pathological processes. Taylor (23) notes particularly its presence in old wounds of low acidity where it has a tendency to delay healing. From these lesions it is eradicated with difficulty but clears up by the use of dilute acetic acid. In 1898 Lartigau (24) in a series of one hundred autopsies reported its occurrence in conjunction with *B. proteus vulgaris* in the kidney and bladder in three cases. Barker (25) in making a systematic bacteriological examination of eight hundred autopsies at the Johns Hopkins Hospital found *B. pyocyaneus* in the kidneys and bladder in eleven cases. He points out that *B. pyocyaneus* is on rare occasions the cause of chronic and acute cystitis associated with or without other organisms and is not

a post partum invader. In eighty autopsies, Hauser (26) reported one case of renal involvement in which the organism was found in pure culture and four cases in which this organism was found in symbiosis with *B. coli* and streptococci. Bernhard (6) reports a case presenting marked symptoms of cystitis, swelling of the testes, toxemia and death in which *B. pyocyaneus* had been recovered from the urine during life and in which it was cultured at autopsy from the prostate as well as from the urinary organs.

B. pyocyaneus probably enters the body through abrasions of the bucco-pharyngeal mucous membrane or the skin, teeth, tonsils, lungs or intestines and is transported by the blood stream to all parts of the body including the genito-urinary tract. Freeman (27) states that the organism does not live in the blood stream as a true parasite but uses the blood as a means of transportation, therefore, the blood examined may show the organism only at intervals. Wherever it lodges it multiplies rapidly forming hemorrhagic infarcts and epithelial degeneration. Lannay (28) points out that it may result in either a local or a general type of infection. In weakened, debilitated individuals, it may take the form of a severe septicopyemia and often terminates fatally.

A probable avenue of invasion of the upper urinary tract is the ascending lymphogenous route in those cases in which a focus exists in the lower portion of the tract. The work of Sweet and Stewart (29) seems to indicate that the anastomoses of the extensive net work of lymphatic vessels and channels existing in the mucosa and sub-mucosa of the external coats of the bladder, ureters and kidneys may be a means of transporting infection upward. They favor the belief that infection travels up the lymphatics and not up the lumen of the ureter or up through its blood vessels. Frank (30) shows direct lymphatic connection between the ascending colon and the capsule of the right kidney and that a similar condition probably exists between the left kidney and the descending colon. To those who favor this route as the means of transportation of organisms from the gastro-intestinal tract to the kidneys, the observations of Frank

are of particular significance in regard to the *B. pyocyaneus* because of the great frequency of its appearance as the cause of infectious diarrhea of the type described by Lartigau (31).

In regard to renal infections in general, Cabot and Crabtree (32), however, claim that the hematogenous route is the most probable one. The tendency of most of the more recent investigators is away from the older idea of the French school of direct ascending infection along the lumen of the ureter. This route is still generally accepted in those cases complicated by urinary stasis.

The work of Alvarez (33) in the gastro-intestinal tract has called attention to the frequency of the reversal of peristalsis. A similar condition of anti-peristalsis does occur in the ureter. Cabot and Crabtree (32) saw a calculus pass from the kidney pelvis to the lower ureter and back again to the kidney. Kretschmer (38) and other investigators have made similar observations. Observations of this nature would be difficult to explain except by reverse peristalsis. Substances opaque to the X-ray, having been injected into the bladder for diagnostic purposes, have been revealed by roentgenograms in the renal pelvis. We have seen materials such as argyrol, having been injected into the bladder for the purpose of prophylaxis against infection, revealed at autopsy in the tubules and glomerular capsule of the kidney. It has been demonstrated clinically and experimentally by roentgenology in cases when there is no disease of the genito-urinary tract, that fluids, such as thorium, collargol and argentos can travel from the bladder to the kidney by reverse peristalsis. Alksne (39) irritated the bladder end of the ureter by electrical stimuli and produced pronounced anti-peristalsis of the ureter. Because of these observations one must bear in mind the possibility of direct ascending infection up the lumen of the ureter by means of reverse peristalsis. When the resistance of the bladder is lowered by the presence of stones, tumors or foreign bodies, *B. pyocyaneus* can more readily invade the bladder, causing cystitis. The vicious circle of irritation thus set up does a great deal to favor the occurrence of reverse peristalsis in the ureter and consequently bring about ascending infection

through its lumen. This is a possible route of infection in our own case which was complicated by a bladder papilloma.

Table 1 presents a summary of those cases of *B. pyocyaneus* infection of the upper urinary tract previously reported in the literature. Detailed report of our own cases follows:

CASE REPORT

Mr. I. V., Portuguese, male. Age fifty-seven, laborer, married.

Complaint. Hematuria, pain on urination, loss of sexual power.

Family and past history. Irrelevant. Syphilis and gonorrhea denied.

Present illness: For the past four years the patient has experienced malaise, general weakness, cloudy urine and diminution in sexual power. One and a half years ago he noted for the first time a drop of blood at the end of urination. Then upon an average of once a month the urine periodically became bloody. There was increased frequency with nycturia. He suffered no diminution in size, force or projection of the urinary stream. The stream was never interrupted. No gravel or stones were passed at any time. A dull pain was felt in the suprapubic region and a slight intermittent ache was noted in both lumbar regions. This pain was non-radiating in character, not influenced by exercise and not related to urination. There were no attacks of Dietl's crisis. His weight remained stationary. On August 27, 1921, he passed a considerable quantity of blood, at which he was alarmed. The physical examination was negative except that there was tenderness in both kidney regions. The lower pole of the right kidney was definitely palpable.

The three glass test was made on August 31, 1921, which showed bloody urine and shreds in all three glasses. By September 6, the urine had cleared of blood but remained cloudy, and, on being allowed to stand, took on a blue-green color. The prostate and seminal vesicles were negative to palpation. Expressed secretion showed lecithin 98 per cent—leucocytes 2 per cent. A no. 26 French bougie à boule passed freely into the bladder.

Phenolsulphonephthalein test. First hour, 42 per cent; second hour, 20 per cent.

Plain X-ray of kidneys, ureters, bladder. Negative.

Cystoscopic examination showed residual urine—none, bladder capacity, 200 cc. vesical neck, hyperemic. The blood vessels of the

TABLE 1
Pyelitis; summary of cases of upper urinary tract infection of Bacillus pyocyaneus diagnosed during life

AUTHOR	PATIENT	DIAGNOSIS	BASIS OF DIAGNOSIS		ACIDITY OF URINE	ACCOM-PANYING ORGANISM	TREATMENT	TERMINATION	REMARKS
			Ureteral catheterization	Symptoms only					
1. Chute		Pyogenic infect. upper urinary tract							
2. Chute		Same							
3. David		Non-tuberculous disease of bladder and kidney							
4. David		Same							
5. Scheidman-del		Cystitis and doubtful pyelitis							
6. Haines	Male, age 34	Pyelitis	Twice	Frequency painful urination chills Pain in loin and frequency	Acid		Renal drainage vaccine and vesical lavage Vesical lavage with antiseptic substances	Good clinically final cultures not stated Good—no final culture report	
7. McWeency	Female	Cystitis and doubtful pyelitis			Acid				
8. Hubener	Age 13	Cystitis		Frequency and dysuria	Acid			Death in 28 days	Autopsy—pyocyaneus in bladder left kidney pelvis and lower pole right kidney
9. Cecil and Hill	Male, age 35	Cystitis pyelitis	Numerous	Pain in right loin temperature chill renal colic	Acid	Actinomycosis in opposite kidney only	Renal lavage	Unknown patient did not return	

10. Lenoir	Male, age 26	Vesical stone with cystitis	Once	Pain in loin	Acid Strongly acid	B. coli	Lithotripsy	Death	Autopsy not given
11. Kleinberger	Male, age 37, teacher	Pyelitis cystitis	Once						
12. Campbell		Pyelitis	Once						
13. Aschner	Male, age 35	Left pyelone- phritis and cystitis	Once	Frequency pain- ful urination, vertigo, vomit- ing	Acid	Staphylococcus albus	Nephrectomy left kidney in- fected by B. pyocyaneus	Cure	
14. Heiman	Male, age 5	Bilateral urete- ral stricture hydroureter cystitis	Once	Fever headache hematuria and lumbar pain			Vaccine injec- tions	Temporary cure only	

trigone were moderately injected. The ureteral orifices were normal in appearance. In the second bladder zone to the right of the right ureteral orifice and a little above, was seen a small irregular villous tumor mass which is very hyperemic in certain areas. There were no bleeding points noted in the bladder at this time. A few areas of coarse trabeculations were noted. No diverticula or foreign bodies were seen. The blood vessels of the bladder walls were dilated and increased in number.

A no. 5 French catheter passed freely into both renal pelves, meeting no obstruction along the course of either ureter. The urine from the right kidney appeared in an intermittent stream, was cloudy and showed numerous red blood cells, leucocytes and gram negative rods which on culture proved to be *B. pyocyaneus*. Guinea-pigs inoculated with urine from the bladder, right kidney and left kidney were negative for tuberculosis. The findings in the left kidney and the bladder are similar to those of the right kidney. Phenolsulphonephthalein appeared on the right side in five minutes and in the first fifteen minutes 6 per cent was recovered and in the second 5 per cent making a total of 11 per cent. On the left side the appearance time was five minutes. Sixteen per cent was recovered in the first and 4 per cent in the second fifteen minutes, making a total of 20 per cent.

Hospital no. 5262.

On September 10, 1921, a piece of the papillomatous mass in the second bladder zone was removed with the rongeur forceps. Pathological study revealed it to be a characteristic bladder papilloma with no evidence of metastasis or other signs of malignancy. September 10, 1921, this tumor mass was thoroughly fulgurated. Roentgenologic study showed both kidneys to be normal in size with no evidence of stone. Pyelography showed a low right kidney with normal calices and with an acute angle at the uretero-pelvic junction. The left kidney showed no abnormality, the pelvis and position being normal.

October 1, 1921, 'Phthalein, first hour 40 per cent; second hour 20 per cent; total 60 per cent. Both ureters were catheterized and revealed the infection to still be present. Six cubic centimeters of mercurochrome 220 (1 per cent) were instilled in both renal pelves. The resulting slough of the fulgurated papilloma was seen to be doing nicely. On October 8, 1921, 6cc. of 1 per cent silver nitrate were instilled into both renal pelves.

Two months later the patient reported feeling greatly improved. He had gained 8 pounds. The lumbar and suprapubic pain, hematuria,

frequency and nycturia had all disappeared. The urine in all three glasses was clear with no shreds. Cystoscopic examination showed that the papilloma in the second bladder zone had entirely disappeared and in its place was seen a white scar. Both ureters were catheterized. The urine from the right kidney showed a few white blood corpuscles, masses of red blood cells, rare epithelial cells and no casts; was clear, showed no organisms and was sterile to culture. The left kidney and bladder urine were also sterile to culture and showed no organisms.

Culture report, by Dr. Elmer Smith. (1) The growth on Russel's double sugar agar failed to produce acid or gas. After forty-eight hours a bluish-green pigment spread throughout the media. The surface growth was greenish, sticky and moist. Smears showed a gram negative bacillus, actively motile and having a tendency to grow out in threads or filaments. A pellicle was formed on glucose bouillon. The odor was quite characteristic and musty. (2) Gelatin stab culture was rapidly liquified. The growth on potato media was moist. At first a dirty brown color developed, and in forty-eight hours, it had changed to a greenish color; which after a week became deep olive with a distinct bluish tinge. The pigment developed best in the solid media. An emulsion of the agar extracted with chloroform showed a bluish chloroform soluble pigment which crystallized into long bluish spicules of pyocyanine.

It may be remarked that the *B. pyocyaneus* has also been often recovered from the urine of persons suffering from cystitis with or without bladder stone. Motz, and later Kleinberger, report cases in which the organism was found associated with stone in the bladder and kidney. Oettinger, Bernhardt, Brown and Jadkewitsch recovered the organism in apparently uncomplicated cases of cystitis. The organism does not always confine itself to the urinary tract but invades the genital tract as well. Hirschberg and Bernhardt report invasion of the epididymis and Perkins observed cases in which it has occurred in the testis and uterus.

Because of the extreme infrequency of the infection of *B. pyocyaneus* in the uro-genital tract, we consider it well to enumerate these cases in which it was found in the University of California Hospital files. In two thousand urine culture reports only seven cases showed the organism. These cases in brief are as follows:

Case 1. (Private case of Dr. Hinman.)

Miss D. V. E., Hospital no. 596. Age six.

First entry. September 2, 1918.

Complaint. Thick shreds in urine with pus. Burning and pain on urination. Diffuse cystitis. Bilateral pyelitis. Repeatedly negative to culture. Thought to be tuberculosis.

Second entry. April 14, 1921.

Bilateral hydronephrosis. Plastic operation on kidney pelvis. Bilateral hydroureter with stricture of ureters. Bilateral pyelitis and cystitis.

May 1 and May 18. Ureteropyeloplasty.

In nine cultures from the bladder and kidney, *B. pyocyaneus* was once found with *B. coli* in the bladder urine only.

Case 2. (Private case of Dr. Hinman.)

Mr. R., Hospital No. 10002. Age thirty-four.

Case of pyelonephritis.

Prostatitis, renal calculi and cystitis. (Colon bacillus.) Localized hydrocalycosis right kidney operated. Nephrotomy, also chronic prostatitis and bilateral epididymitis. On April 26, 1921, *B. pyocyaneus* was found in symbiosis with *B. coli* and *B. paracoli*. It was never recovered from the kidneys.

Case 3. (Referred from the Out-patient Department.)

Mrs. C., Hospital No. 11002. Age thirty-seven.

Left tuberculous pyonephrosis and cystitis. Fecal fistula. Urinary fistula. Bladder stone. Polypi in bladder. Tubercle bacillus never found. Nephrotomy. Nephrectomy (typical left tubercular kidney). On February 12, 1921, *B. pyocyaneus* was found in symbiosis with *B. coli* and *B. proteus*. It was never recovered from the kidneys.

Case 4. (Private case of Dr. Hinman.)

Mr. H. D., Hospital No. 6521. Age twenty-five.

Tuberculosis of left kidney and bladder.

Nephrectomy left side.

On April 15, 1920, *B. pyocyaneus* was found in bladder urine with *staphylococcus albus*. It was never recovered from the kidneys.

Case 5. (Referred from the Out-patient Department.)

Mr. P., Hospital No. 1159.

February 24, 1918. Large stone right kidney pelvis. Stone in lower pole left kidney.

October 1, 1918. Left ureteronephrolithotomy.

March 4, 1920. Large stone right kidney. Several small stones left kidney. Large stone upper left ureter.

March 20, 1920. Left ureteronephrolithotomy.

April 13, 1920. Right nephrolithotomy.

October 17, 1921. Large staghorn calculus right kidney.

October 20, 1921. Right nephrolithotomy.

In this case the urines were drained from both kidneys thirty-one times from September 26, 1916, to December 15, 1921. On April 6, 1920, *B. pyocyaneus* was recovered from the left kidney and from the bladder with *B. coli*. On May 15, 1920, it was again found with *staphylococcus albus* and *B. coli* in the bladder. May 19, 1920, *B. pyocyaneus* was again cultured from the bladder with *B. coli*. May 25, 1920, it was grown from the right kidney and bladder urines. *B. coli* accompanied it in the bladder.

Case 6. (Referred from the Out-patient Department.)

Mr. J. N., no. 63607. Age seventy-three.

Patient had had prostatectomy and lithrotrity for vesical calculus. Now has "pain in testes," "soreness in rectum," nycturia 1, dysuria 3-4. Small gravel particles present in urine. Ureters not catheterized. *B. pyocyaneus* was cultured from the catheterized bladder urine.

Case 7. (Referred from the Out-patient Department).

Mr. A. J., No. 63576. Age seventy.

Cystitis. Has frequency and urgency and later incontinence of urine. Cystoscopy reveals the presence of cystitis and trigonitis. Ureters not catheterized. *B. pyocyaneus* was grown from the bladder urine.

In reviewing eighteen hundred urine culture reports on file from the Stanford University Hospital, six showed the organism. These cases in brief are as follows:

Case 1. Mr. N. A., Hospital No. 49710. Medical Service.

Patient had cystitis complicating typhoid fever. Blood culture positive for *B. typhosis* and the Widal was positive. January 1,

1917, the *B. pyocyaneus* was recovered from the bladder urine where it was found in symbiosis with *B. coli* and some gram positive diplococci.

Case 2. Mr. J. O., Dispensary No. 33173. Male. Age fifty. Laborer.

Patient complained of retention, frequent urination and nycturia. He disappeared before diagnosis was established. *B. pyocyaneus* was cultured from bladder urine only.

Case 3. Mr. J. R., Dispensary No. 11879. (Service of Dr. Rigdon.) Male. Age thirty-four.

Patient complained of frequent urination and pain in bladder during micturition. Pain in right lumbar region.

Had nephrotomy and cystotomy previously.

Had renal lavage for bilateral pyelitis.

Final outcome unknown.

On March 2 and 18 and February 11, 1914, *B. pyocyaneus* was cultured from the bladder with streptococci. Streptococci alone was found in the renal pelves.

Case 4. (Private case of Dr. A. A. Reed.) Mrs. L. L. K. Female. Age twenty-five.

Patient seen January 28, 1916, with tetany and rheumatic endocarditis. April 3, 1916, she developed acute cystitis with probable pyelitis.

April 29, 1916, *B. pyocyaneus* with streptococci were found in the bladder urine. Ureters not catheterized. Then developed ascites and uremia of nephritic type.

Patient died July 31, 1916, and autopsy not stated.

Case 5. (Private case of Dr. Hinman.) Mr. G. L. B. Male. Age seventy.

Culture taken at Stanford Hospital. Patient transferred to University of California Hospital. Hospital No. 9726.

Patient complains of frequency, difficulty in urination, lumbar pain and weakness. Cystitis, bilateral pyelonephritis, prostatic hypertrophy and contracture of the vesical neck. Perineal prostatectomy in August, 1915. April 12, 1915, *B. pyocyaneus* with streptococci were cultured from the bladder urine. Urinary tract infection treated with vaccines. Personal communication with Dr. Hinman reveals that pyuria has persisted.

Case 6. (Private case of Dr. Luttrell.) Mr. T. Male. April 22, 1912.

History of this case not available.

The *B. pyocyaneus* was cultured from the urine.

B. pyocyaneus occurs in about 0.25 per cent of genito-urinary infections or one in every 393 cases. Its incidence is probably higher than in indicated above because in routine culture the organism is not grown sufficiently long to determine its identity. In some instances it may be therefore confused with *B. proteus*. The characteristic blue-green color often does not appear until after forty-eight hours incubation. In positive cultures one can always crystalize out the characteristic crystals of pyocyanine, verifying its presence. In our own cultures, 3 in 529 were proven

TABLE 2

Table of incidence of Bacillus pyocyaneus in urinary tract

HOSPITAL	TOTAL NUMBER OF CULTURES	CASES REPORTED		TOTAL
		Pelvis	Bladder	
University of California since 1916	2000	1	6	7
Stanford since 1912	1800	0	6	6
St. Mary's since 1919	529	2	1	3
Total	4329	3	13	16

to be *B. pyocyaneus*. This greater incidence is explained by the fact that by making routine cultures, the organisms were grown five to seven days, and in doubtful cases, the tests for the crystals of pyocyanine were made. Table 2 summarizes the incidence of *B. pyocyaneus* in the urinary tract in three San Francisco hospitals.

TREATMENT

In those cases of fulminating general infection by *B. pyocyaneus* accompanied by chills, fever, malaise, prostration and later death, the presence of the infection in the genito-urinary tract is part of a general invasion, and local treatment either in the kidneys and bladder would be useless. Table 3 presents an outline of the results obtained in six cases of *B. pyocyaneus*

TABLE 3
Résumé of treatment and results of 6 reported cases of B. pyocyaneus pyelitis proven by ureteral catheterization

AUTHOR	RENAL LAVAGE	RENAL DRAINAGE	VESICAL LAVAGE	VACCINES	NEPHRECTOMY	INTERNAL MEDICATION	RESULTS
Haines		Twice	Numerous boric acid instillation of 5 cc. novocain	Given one billion per centimeter		Yes, potassium bromide and hyocyamus	Good clinically—not checked with culture
Cecil and Hill	Numerous	Numerous	Numerous			Yes	Patient disappeared
Kleinberger Campbell and Rhea Aschner		Once Once Once	Numerous with retention catheter		Nephrectomy of left infected pyonephrotic kidney	Yes, hetralin	Good—prostatectomy done later, good
Heiman		Once		5 injections vaccine (50 million) one week interval			Temporary cure only

pyelitis reported in the literature, the diagnosis of which has been confirmed by ureteral catheterization.

In localized infections of the urinary tract local treatment is of great value. In our case, renal and vesical lavage were employed. The treatment consisted of instillations of mercuriochrome 220 (1 per cent) and later silver nitrate (1 per cent) into both renal pelves at seven day intervals. The bladder was daily irrigated with potassium permanganate (1:4000) followed by instillations of 10 per cent argyrol. This treatment was supplemented with internal medication consisting of hexamethylenamine 1 gram three times a day one hour before meals and acid sodium phosphate 1.5 grams three times a day after meals.

Following the second renal lavage sterile cultures were obtained. If the case had proven resistant to this form of treatment, vaccines would have been used.

DISCUSSION

B. pyocyaneus is prevalent in nature as a saprophyte. It is commonly found in the soil where it occurs as one of the principal diamidizing agents. In man it exists occasionally as a saprophytic organism on the skin, buccal and pharyngeal membranes and in the bronchial tubes. When one considers how frequently *B. pyocyaneus* is found as a saprophyte, its rarity as a pathogenic organism is the more remarkable. It is with greater rarity that it localizes itself in the genito-urinary tract causing disease. It is particularly rare as a sole cause of pyelitis, only fourteen cases having been collected from the available literature, but six of which were proven by the ureteral catheter.

The most probable route of infection of the kidneys is through the blood stream. The *B. pyocyaneus* may enter the body through abrasions of the bucco-pharyngeal membranes or the skin, teeth, tonsils, lungs or intestines and is transported by the blood stream into the kidneys causing a local infection such as pyelitis. In weakened, debilitated individuals, it may result in a severe septicopyemia, often terminating fatally. Another probable avenue of invasion is the ascending lymphogenous route

in those cases in which a focus exists in the lower uro-genital tract. The present tendency in the recent literature is away from the older idea of the French school of direct ascending infection through the lumen of the ureter (David (36)). This route is still generally accepted in cases complicated by urinary stasis. The work of Alvarez (33) on the gastro-intestinal tract has called attention to the frequency of the reversal of peristalsis. A similar condition of anti-peristalsis does occur in the ureter. Observers have seen calculi pass from the kidney pelvis to the lower ureter and back again to the kidneys. Substances opaque to the X-ray having been injected into the bladder for diagnosis and prophylaxis against infection have been revealed by roentgenograms in the renal pelvis, and at autopsy in the tubules and glomerular capsule of the kidney. Cystitis due to *B. pyocyaneus* is often accompanied by stones, tumors or foreign bodies because of the lowered resistance of the bladder occasioned by the presence of these objects. The vicious circle of irritation thus set up does a great deal to favor the occurrence of reverse peristalsis of the ureter and consequently bring about ascending infection through its lumen. This is a possible route of infection in our own case which was complicated by a bladder papilloma.

Early recognition and treatment of *B. pyocyaneus* infection of the upper urinary tract is of great importance because of its occasional severity. Two of the fourteen reported cases, or 14.4 per cent, where this condition was diagnosed in the upper urinary tract terminated fatally in a brief period. Another of this group of fourteen cases had temporary relief only, and the ultimate outcome of the disease was not stated. A fourth case developed pyonephrosis, necessitating nephrectomy. One must bear in mind, however, the probability of the more severe type of case as the one reported.

Early diagnosis of *B. pyocyaneus* pyelitis is of importance because of the necessity of choosing the proper course of treatment. Renal drainage and lavage should be employed at once, and, in resistant cases, autogenous vaccine should be added to the therapy.

SUMMARY

1. *B. pyocyaneus* is a relatively rare invader of the upper urinary tract as a cause of pyelitis. In comparison to other well known organism, it occurs in exceeding rarity. In a total of eight hundred and thirty five cases of upper urinary infection compiled by reports of various authors appearing in the literature, the invading organisms occur in the following incidence:

<i>B. coli</i>	631
<i>Staphylococcus aureas</i> and <i>albus</i>	89
<i>Streptococci</i>	34
<i>B. acidi lacti</i>	16
<i>Diplococcus</i>	12
Miscellaneous	10
<i>Pneumococcus</i>	8
<i>B. influenza</i>	8
<i>B. proteus</i>	8
<i>B. lacti aerogenes</i>	7
<i>B. typhoid</i>	4
<i>B. pyocyaneus</i>	3
<i>B. paratyphoid</i>	2
<i>B. enteridites</i>	1
<i>B. faecales alcaligenes</i>	1
<i>Pseudodiphtheroid</i>	1
	<hr/>
	835

2. The incidence of occurrence of *B. pyocyaneus* in the urinary tract in three San Francisco hospitals is as follows:

In 4329 urine cultures reviewed by us, 16 cases were found, 3 in the renal pelvis and 13 in the bladder.

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THE PATHOLOGIC CHANGES IN EXPERIMENTAL, ASCENDING AND HEMATOGENOUS PYELITIS¹

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There are practically no comparative studies on the pathologic anatomy of experimental pyelitis which deal with the localization of the inflammatory processes in the various portions of the kidney including the pelvis. This is, in a large measure, due to the difficulty in producing pyelitis by the ascending route without interfering with the flow of urine. At first longitudinal sections of the kidney were made and thus only a small part of the pelvis was available for study in blocks taken from the kidney. In the later experiments, however, transverse sections of the kidney were made and a complete cross section of the entire kidney was used for histologic study. In this manner the relation of lesions of the cortex, medulla, papilla, both walls of the pelvis, the peripelvic fat, and occasionally portions of the ureter are available for study.

The localization of inflammatory processes in the different portions of the kidney including the pelvis was studied in 33 animals. It was our particular interest to see whether we could differentiate the pictures of hematogenous and ascending pyelitis. We had available for this purpose 20 kidneys from animals with pyelitis produced by intravenous injection of *Bacillus coli communis* and 13 kidneys from animals with pyelitis produced by intracystic injection. The infected animals were killed from three to twenty-one days after injection, the majority after about five days.

¹ Presented before the Association of American Pathologists and Bacteriologists. Washington, D. C., May, 1922.

HEMATOGENOUS INFECTION

Of the twenty animals with evidence of pyelitis, all but two had histologic evidence of involvement of the substance of the kidney. Only single blocks of tissue were available for study in the two without apparent involvement of the kidney and so this cannot be definitely excluded.

The involvement of the kidneys can be grouped as (1) cortical abscesses, six cases, (2) medullary abscesses, three cases, (3) medullary and cortical abscesses, six cases, and (4) leucocytic accumulations in capillaries of the papilla, four cases.

By means of a diagram (fig. 1) of a transverse cross section of the kidney at about the middle, it is possible to locate graphically the inflammatory reaction in the various parts of the kidney substance and pelvis. By comparing the diagrams of the 20 kidneys, one is able to obtain a composite picture of possible locations of the lesions in this type of infection. Six have been selected to illustrate the various types of lesions produced. Two show involvement of the pelvis alone (figs. 2 and 3); 2 show the cortical and medullary abscesses with pyelitis (figs. 4 and 5); and 2 show an increase of leucocytes in the capillaries of the papillae (figs. 6 and 7). The photomicrographs show in detail subepithelial infiltration of the pelvic lining of the papillae (fig. 8), and the unusual diffuse filling of the capillaries of the papilla with leucocytes (fig. 9).

The characteristic features in this series of 20 cases are (1) the uniform involvement of the kidney in either the cortex or medulla, (2) the localization of the inflammatory reaction in the pelvic lining of the papillae and adjacent mucosa, and (3) the complete freedom of reaction (with one exception) of the peripelvic fat. This exception (fig. 10) was marked by the unusual size of the cortical abscess immediately adjacent to the peripelvic fat and probably involving it by direct extension. The freedom from inflammation of the peripelvic fat is emphasized as a negative feature in the findings because it is in such contrast to that found in about one-half of the ascending group.

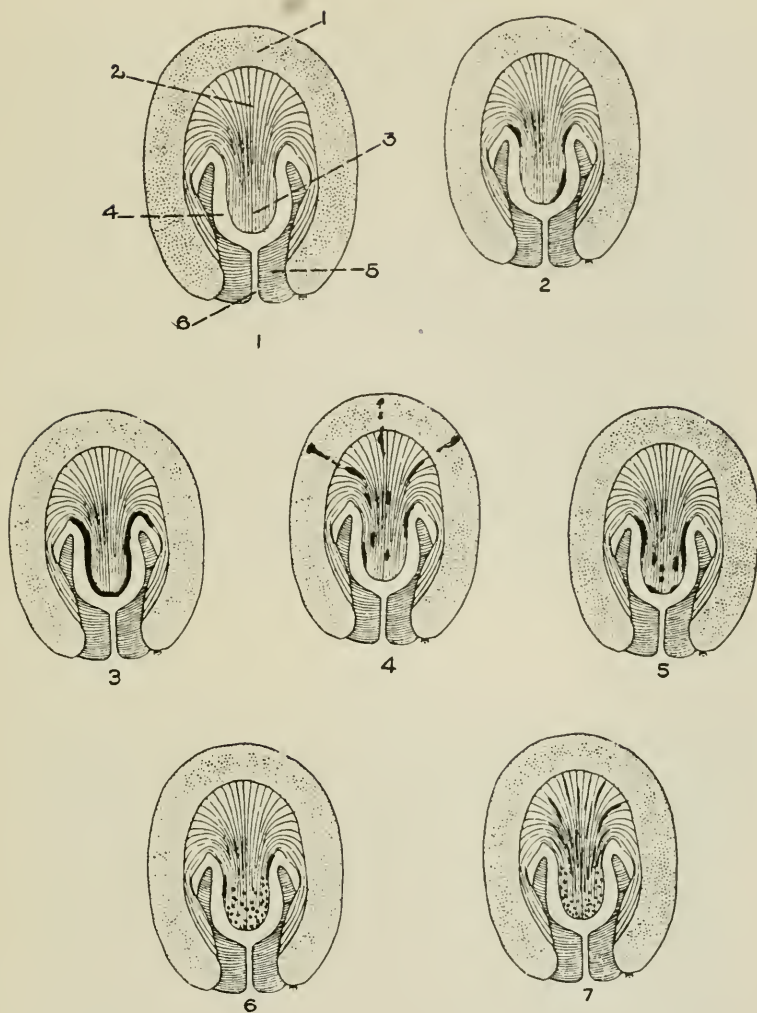


FIG. 1. 1, CORTEX; 2, MEDULLA; 3, PAPILLA; 4, PELVIS; 5, PERIPELVIC FAT; 6, URETER

FIGS. 2 AND 3. SUBEPITHELIAL INFILTRATION OF THE PELVIS

FIG. 4. MEDULLARY AND CORTICAL ABSCESES

FIG. 5. MEDULLARY ABSCESES

FIG. 6. CAPILLARY ENGORGEMENT OF THE PAPILLA WITH LEUKOCYTES

FIG. 7. ENGORGEMENT EXTENDING UP INTO THE MEDULLA

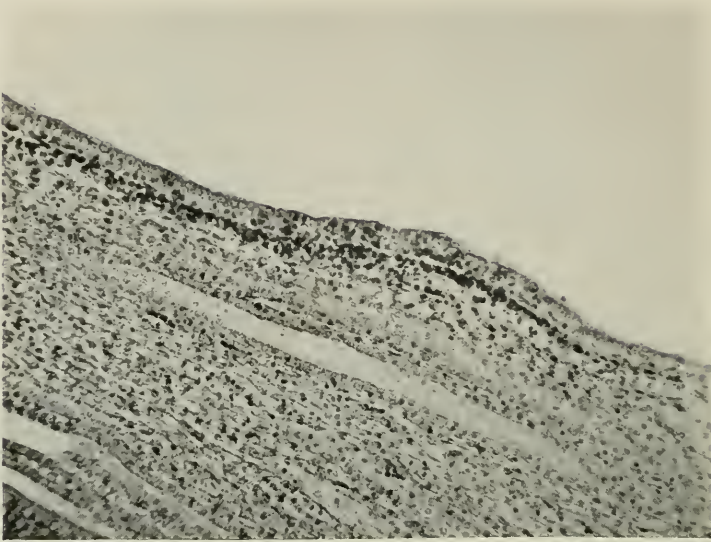


FIG. 8. SUBEPITHELIAL INFILTRATION OF THE PAPILLA

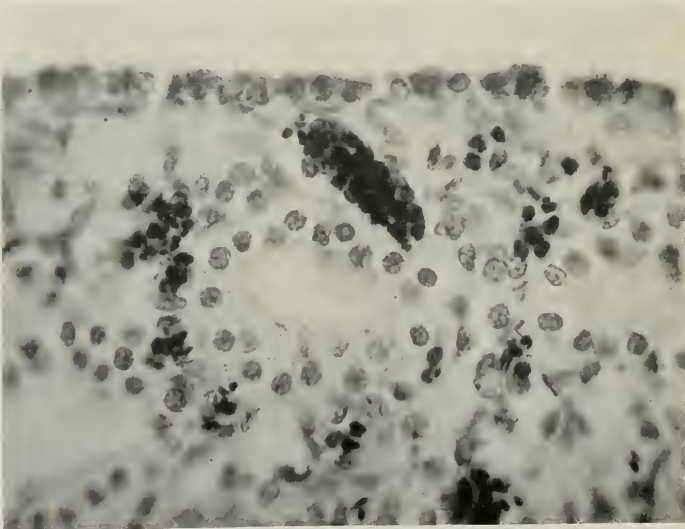


FIG. 9. CAPILLARIES OF THE PAPILLA FILLED WITH LEUKOCYTES

ASCENDING INFECTION

The group with ascending infection consists of 13 animals in which pyelitis was produced by merely introducing bacteria into the bladder without irritation of the bladder or obstruction to the flow of urine. Twelve animals had inflammatory infiltration of the parietal pelvic wall (figs. 11 and 12) formed by infolding of mucosa over the fingerlike projection of peripelvic con-

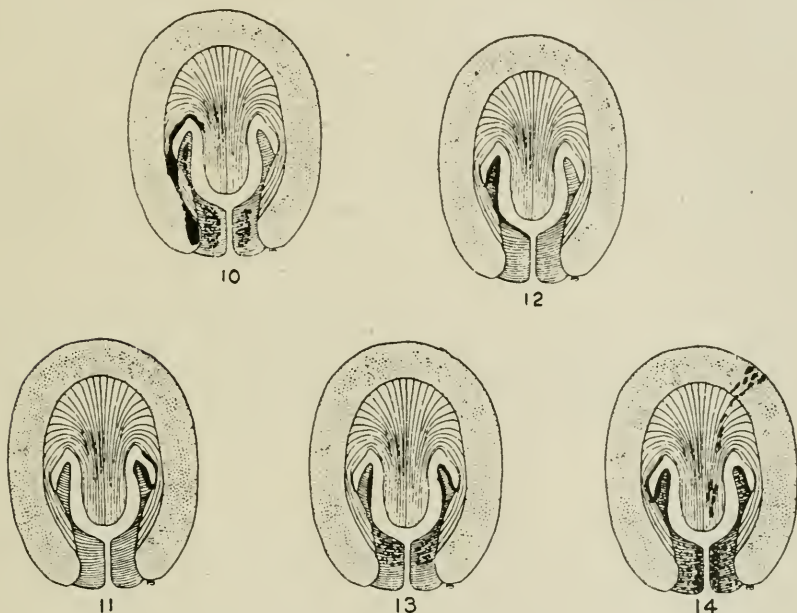


FIG. 10. CORTICAL ABSCESS WITH INFILTRATION OF PERIPELVIC FAT

FIGS. 11 AND 12. INFILTRATION OF THE PARIETAL WALL OF THE PELVIS

FIG. 13. LEUKOCYTIC INFILTRATION OF PERIPELVIC FAT

FIG. 14. PERIURETERAL INFILTRATION. SINGLE GROUP OF CORTICAL ABSCESSES

nective tissue. This infiltration was most constant in the side toward the substance of the kidney. Another characteristic lesion, though not so constant, is the inflammatory reaction in the peripelvic fat (figs. 13 and 14).

In 6 of the 13 cases there was diffuse peripelvic infiltration with polymorphonuclear leucocytes, with extensive hemorrhages in several instances. In three of the 6 instances, there was also a diffuse peri-ureteral infiltration which extended from the bladder

to the peripelvic tissue in the kidney. One of these rabbits had only unilateral involvement. In only one was there involvement of the papilla without marked involvement of the parietal pelvic wall. This occurred in both kidneys and from the histologic examination the infection could be classified in the hematogenous group. The other two instances in which the kidneys were slightly affected represent cases in which the inflammatory reaction was so intense that the process involved the substance of the kidney as well as the pelvis. In one instance a collecting tubule was filled with pus cells and in the other, a group of cortical abscesses was found which in serial sections was traced up the collecting tubules through the medulla to the cortex. These abscesses on the surface of the kidney were limited to one group of tubules; the remainder of the cortex and medulla was entirely free. This is in marked contrast to the hematogenous abscesses which were diffusely scattered throughout the kidney.

In ascending infections the characteristic finding is infiltration of the parietal wall of the pelvis; in about one-half of the cases there is diffuse infiltration of the peripelvic tissues and only occasionally is the substance of the kidney affected.

SUMMARY

Although great care must be exercised in drawing conclusions from experiments on rabbits; nevertheless, if the explanation of the apparent differences in this series has any logical ground, it may be assumed that similar differences will probably appear in the lesions of human kidneys. Concerning the production of such lesions, especially in infants, we are as yet without definite information or any exact criteria for obtaining the information. Utilization of this method in the histologic study of specimens from human beings might be of value.

By means of complete cross sections of rabbit's kidneys it was possible to localize certain processes of infiltrations that characterize hematogenous and ascending infections of the rabbit's kidney. The lesions produced by intravenous injection tend to localize in the kidney substance and in the papilla and adjacent lining of the pelvis. The lesions produced by intracystic injections tend to localize in the small finger-like projection of the parietal wall of the pelvis.

THE RELATIONSHIP OF BLOOD CONCENTRATION TO NITROGEN RETENTION IN EXPERI- MENTAL NEPHRITIS

FRANK P. UNDERHILL AND ROBERT KAPSINOW

From the Department of Pharmacology and Toxicology, Yale University, New Haven

Received for publication August 2, 1922

Production of nephritis by uranium salts has afforded an opportunity to observe the possible relationship of changes in blood concentration to the retention of nitrogenous metabolites.

ERRATUM

306²—

In the article by Underhill and Kapsinow entitled "The Relationship of Blood Concentration to Nitrogen Retention in Experimental Nephritis," appearing in *Vol. VIII, No. IV, p. 307*, in all tables and figures for Creatinine and Creatine of urine the decimal point should be moved one place to the right. The only exception is in Table IV where the Creatine figures are correct.

poisoning (2), influenza (3), and various abnormal states of childhood (4). In experimental nephritis induced by tartrate a marked dilution of the blood may occur (5). It is likewise well known that in experimental nephritis due to administration of uranium salts there is a marked retention of non-protein nitrogen and urea (6).

In the present communication attention has been directed to the relationship existing between changes in blood concentration and retention of nitrogenous substances in the blood in uranium nephritis. It will be shown that, as might be expected, the blood becomes greatly diluted in uranium nephritis and that the extent of dilution bears a direct relationship to the degree of nitrogen retention. If, therefore, the blood dilution increases as nitrogen retention augments it must be evident that the degree of nitrogen

to the peripelvic tissue in the kidney. One of these rabbits had only unilateral involvement. In only one was there involvement of the papilla without marked involvement of the parietal pelvic wall. This occurred in both kidneys and from the histologic examination the infection could be classified in the hematogenous group. The other two instances in which the kidneys were slightly affected represent cases in which the inflammatory reaction was so intense that the process involved the substance of the kidney as well as the pelvis. In one instance a collecting tubule was filled with pus cells and in the other, a group of cortical abscesses was found which in serial sections was traced up the collecting tubules through the medulla to the cortex. These abscesses on the surface of the kidney were limited to one group of tubules; the remainder of the cortex and medulla was entirely

from experiments on rabbits; nevertheless, if the explanation of the apparent differences in this series has any logical ground, it may be assumed that similar differences will probably appear in the lesions of human kidneys. Concerning the production of such lesions, especially in infants, we are as yet without definite information or any exact criteria for obtaining the information. Utilization of this method in the histologic study of specimens from human beings might be of value.

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Production of nephritis by uranium salts has afforded an opportunity to observe the possible relationship of changes in blood concentration to the retention of nitrogenous metabolites. It is a common clinical finding that many cases of nephritis have a moderate degree of anemia and the question has arisen relative to the significance of this anemia both with respect to changes in blood concentration and to increase of the nitrogenous metabolites of the blood.

Changes in blood concentration in various pathological states is rapidly becoming clinically of considerable importance. In this connection it is only necessary to cite the significance of blood concentration in such conditions as cholera (1), war gas poisoning (2), influenza (3), and various abnormal states of childhood (4). In experimental nephritis induced by tartrate a marked dilution of the blood may occur (5). It is likewise well known that in experimental nephritis due to administration of uranium salts there is a marked retention of non-protein nitrogen and urea (6).

In the present communication attention has been directed to the relationship existing between changes in blood concentration and retention of nitrogenous substances in the blood in uranium nephritis. It will be shown that, as might be expected, the blood becomes greatly diluted in uranium nephritis and that the extent of dilution bears a direct relationship to the degree of nitrogen retention. If, therefore, the blood dilution increases as nitrogen retention augments it must be evident that the degree of nitrogen

retention is actually much greater than it apparently appears for the factor of blood dilution is not usually considered in the estimation of nitrogen retention. Moreover, it is quite possible in the future that the determination of changes in blood concentration may prove of value in prognostication in nephritis. Certainly such a procedure would prove less difficult and more rapid than the determination of the non-protein nitrogen of the blood. It would also be of great advantage because of the small amount of blood necessary, thus facilitating the possibility of more frequent determinations.

METHODS

Normal full-grown male rabbits were employed in a fasting condition, water being given *ad libitum*. Urine was collected

TABLE 1
The urine and blood in uranium nephritis
Rabbit 1, weight, 1.7 kilos

DATE	H ₂ O INTAKE	URINE					BLOOD		
		Vol- ume	Total N	Creat- inine	Crea- tine	Esbach	Non- protein N	Creat- inine	Hemo- globin
1921	cc.	cc.	grams	mgm.	mgm.	grams	mgm.	mgm.	per cent
June 24.....	130	60	0.49	8.4		0	39.5	2.0	92
June 25*.....	95	120	0.78	7.3		0.7	76.3	6.5	80
June 26.....	80	90	0.64	4.5		1.5	132.3	9.0	78
June 27.....	230	130	0.30	1.7		1.2	194.4	12.8	67
June 28.....	Dead								

* Day of injection.

in 24-hour periods by compression of the bladder. Total nitrogen, creatinine and creatine were determined on urine specimens and on the blood, drawn from the ear vein each morning, estimations were made for non-protein nitrogen, creatinine, and hemoglobin. In general the methods of Folin and his collaborators were employed. Hemoglobin was determined by the procedure of Cohen and Smith. Uranium nitrate was injected in each instance in the dosage of 10 mgm. per kilo body weight on the second day of the experiment. Control experiments were

considered unnecessary since it has been demonstrated that starvation alone does not appreciably diminish hemoglobin

TABLE 2

The urine and blood in uranium nephritis

Rabbit 2, weight, 2.3 kilos

DATE	H ₂ O INTAKE	URINE					BLOOD		
		Vol- ume	Total N	Creat- inine	Crea- tine	Esbach	Non- protein N	Creat- inine	Hemo- globin
<i>1921</i>	<i>cc.</i>	<i>cc.</i>	<i>grams</i>	<i>mgm.</i>	<i>mgm.</i>	<i>grams</i>	<i>mgm.</i>	<i>mgm.</i>	<i>per cent</i>
June 29.....	200	80	0.55	7.7	2.5	0	139.8	2.0	126
June 30*.....	120	140	0.81	7.2	1.1	0.7	162.6	2.4	91
July 1.....	80	50	0.33	3.0	2.3	1.7	250.0	6.3	66
July 2.....	40	45	0.33	2.3	2.9	2.0	285.0	9.2	63
July 3.....	35	0					310.0	20.0	60
July 4.....	40	4	0.01	0.6	0.1	0.2	373.8	23.5	44
July 5.....	70	85	0.42	3.3	2.2	0.2	600.0	28.5	42
July 6.....	140	180	0.22	5.1	6.2	0.2	624.9	50.0	41
July 7.....	Dead								

* Day of injection.

TABLE 3

The urine and blood in uranium nephritis

Rabbit 3, weight, 1.9 kilo

DATE	H ₂ O INTAKE	URINE					BLOOD		
		Vol- ume	Total N	Creat- inine	Crea- tine	Esbach	Non- protein N	Creat- inine	Hemo- globin
<i>1921</i>	<i>cc.</i>	<i>cc.</i>	<i>grams</i>	<i>mgm.</i>	<i>mgm.</i>	<i>grams</i>	<i>mgm.</i>	<i>mgm.</i>	<i>per cent</i>
July 9.....	95	140	0.88	7.4	3.5	0	72.4	2.5	96
July 10*.....	100	170	0.89	6.7	5.4	0.7	84.7	3.5	90
July 11.....	95	110	0.46	3.2	2.7	1.2	158.7	12.4	77
July 12.....	30	0					206.1	14.6	74
July 13.....	10	0					298.5	17.6	60
July 14.....	40	0					464.4	19.1	50
July 15.....	10	0					515.4	22.2	37
July 16.....	0	0					537.6	26.9	About 10
July 17.....	Dead								

* Day of injection.

values. Moreover, it has been shown previously that the curve of total solids and hemoglobin follow similar if not exactly parallel

courses in tartrate nephritis. Hence in the present work estimation of the total solid content of the blood has been omitted.

TABLE 4
The urine and blood in uranium nephritis
Rabbit 4, weight, 1.8 kilo

DATE	H ₂ O INTAKE	URINE					BLOOD		
		Volume	Total N	Creat- inine	Crea- tine	Esbach	Non- protein N	Creat- inine	Hemo- globin
1921	cc.	cc.	grams	mgm.	mgm.	grams	mgm.	mgm.	per cent
July 21.....	30	28	0.54	9.7	8.9	0	80.6	3.2	120
July 22*.....	70	53	0.57	7.7	14.9	0.5	112.3	4.5	104
July 23.....	45	26	0.09	2.0	12.5	0.2	158.7	6.0	98
July 24.....	20	10 drops					257.0	13.3	66
July 25.....	20	4					283.6	20.0	50
July 26.....	30	0					434.8	22.2	46
July 27.....	25	0					487.8	30.0	45
July 28.....	Dead								

* Day of injection.

TABLE 5
The urine and blood in uranium nephritis
Rabbit 5, weight, 1.7 kilo

DATE	H ₂ O INTAKE	URINE					BLOOD		
		Vol- ume	Total N	Creat- inine	Crea- tine	Esbach	Non- protein N	Creat- inine	Hemo- globin
1921	cc.	cc.	grams	mgm.	mgm.	grgms	mgm.	mgm.	per cent
August 4.....	80	94	0.49	7.7	1.1	0	88.4	2.4	104
August 5*.....	55	68	0.73	7.5	4.7	0.2	90.9	2.6	72
August 6.....	80	105	0.79	6.4	6.2	1.2	119.0	3.5	71
August 7.....	45	74	0.45	3.9	3.3	1.2	181.8	5.1	70
August 8.....	65	16	0.03	0.8	1.8	0.5	291.1	7.1	65
August 9.....	30	0					309.2	9.9	54
August 10.....	20	0					500.0	12.0	48
August 11.....	Dead								

* Day of injection.

As may be seen from the tables all experiments definitely demonstrate that during uranium nephritis there is a marked dilution of the blood as indicated by the hemoglobin figures. Inas-

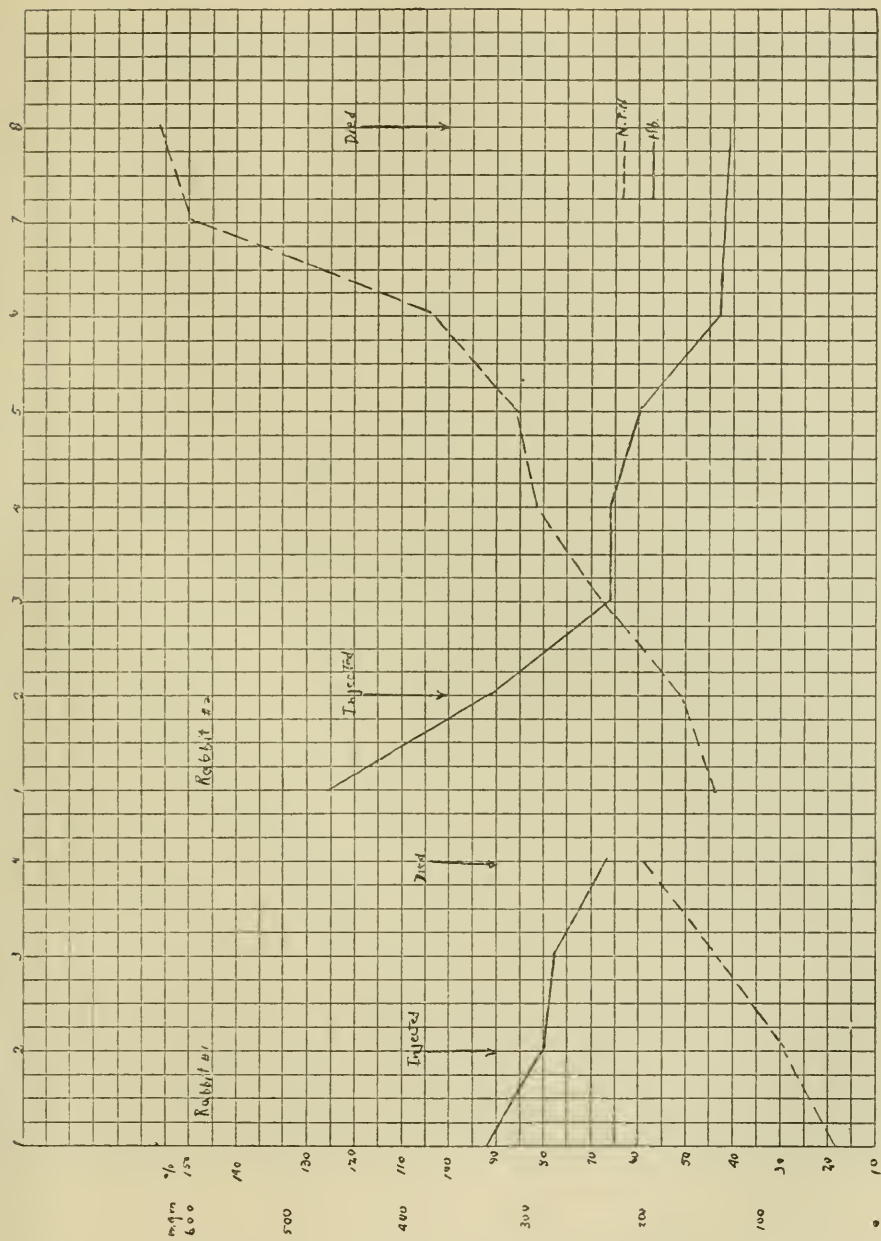


CHART 1. VARIATIONS IN HEMOGLOBIN AND NON-PROTEIN NITROGEN OF THE BLOOD IN URANIUM NEPHRITIS

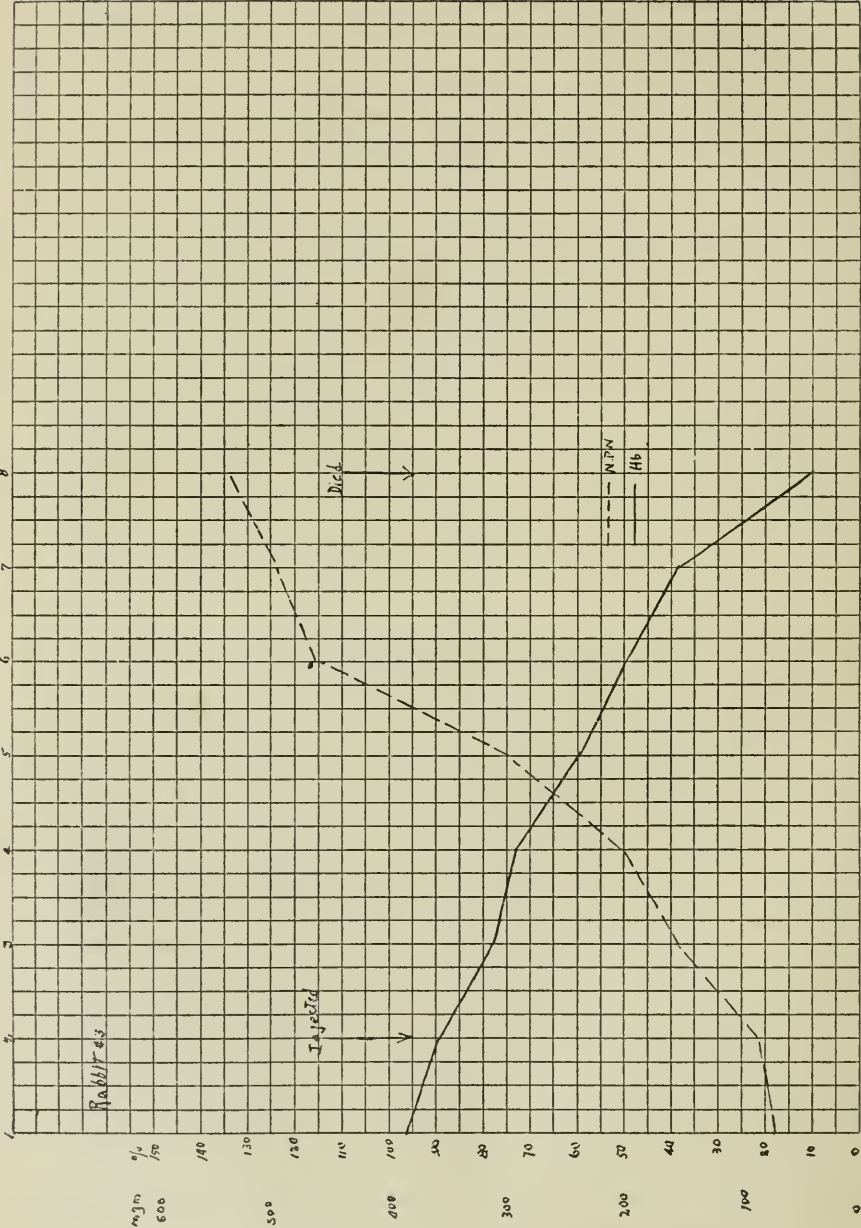


CHART 2. VARIATIONS IN HEMOGLOBIN AND NON-PROTEIN NITROGEN OF THE BLOOD IN URANIUM NEPHRITIS

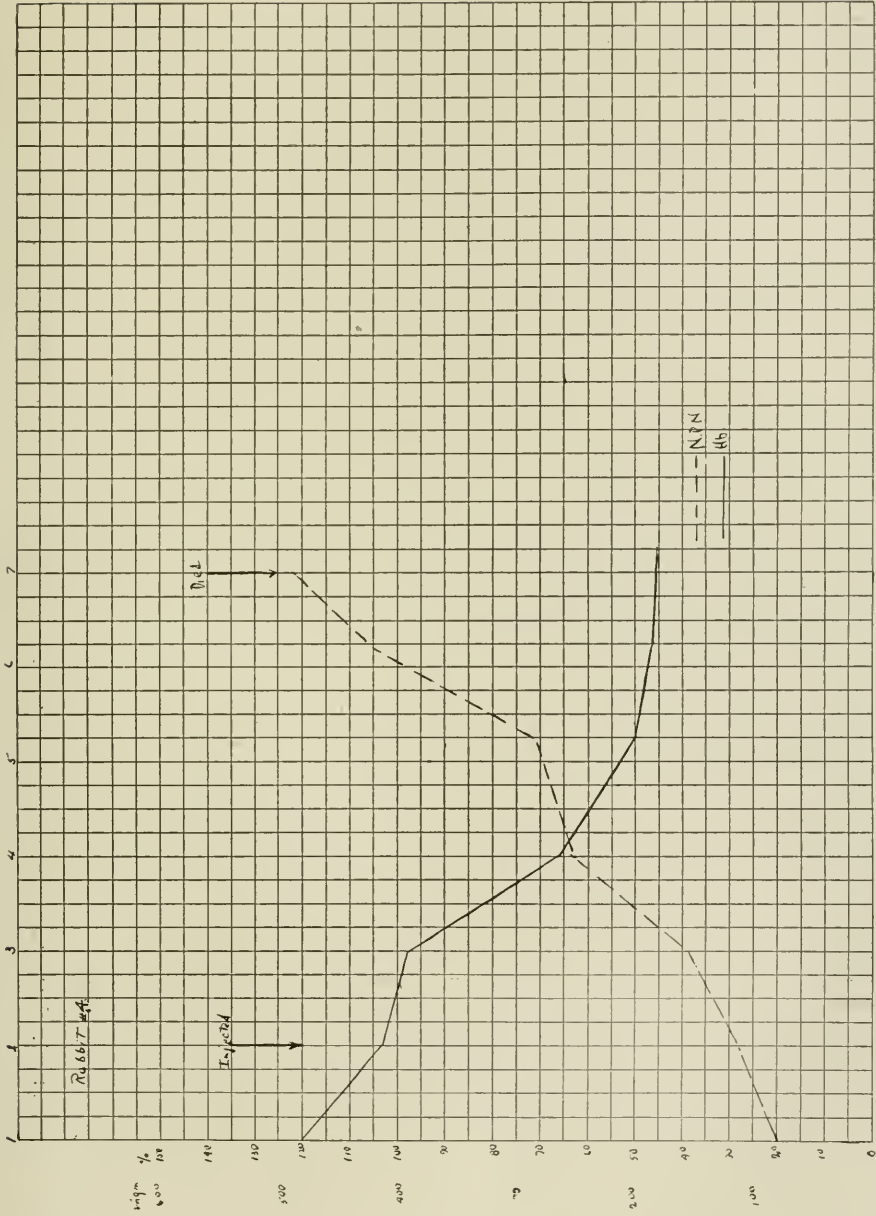


CHART 3. VARIATIONS IN HEMOGLOBIN AND NON-PROTEIN NITROGEN OF THE BLOOD IN URANIUM NEPHRITIS

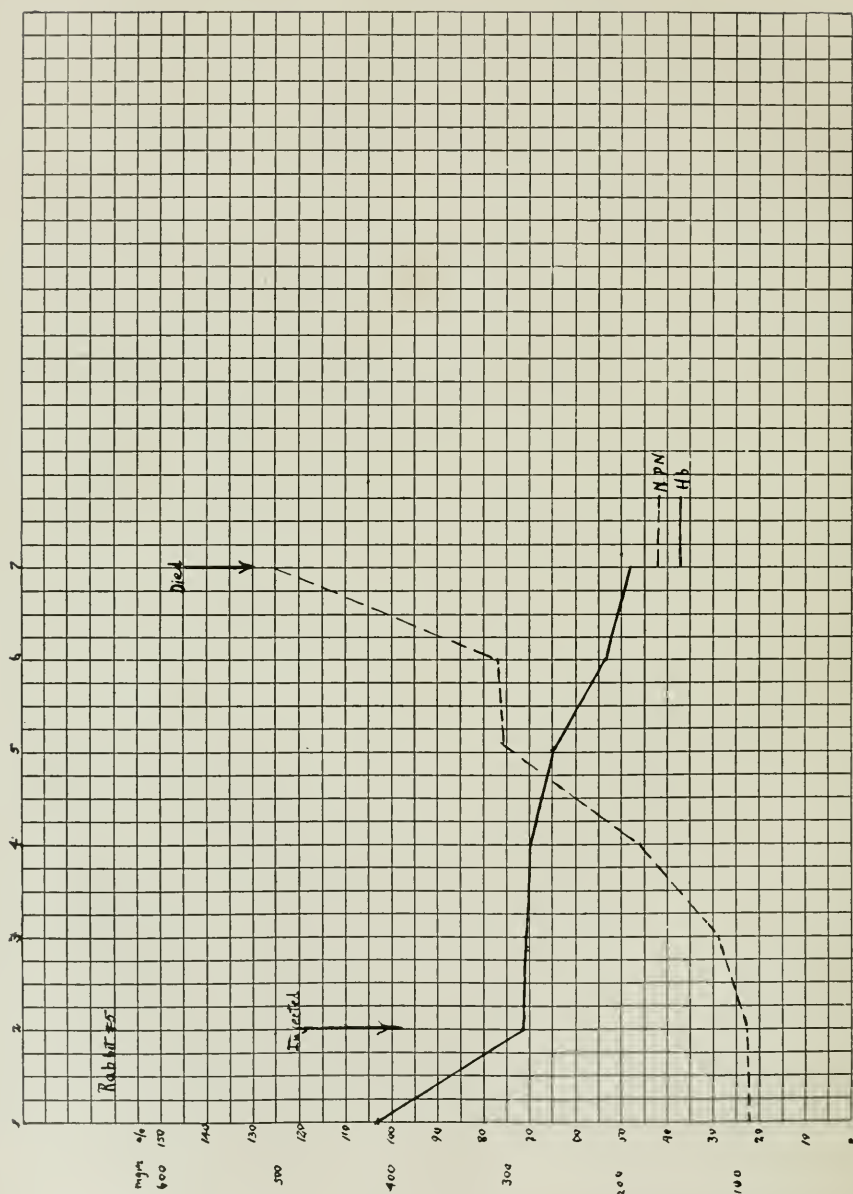


CHART 4. VARIATIONS IN HEMOGLOBIN AND NON-PROTEIN NITROGEN OF THE BLOOD IN URANIUM NEPHRITIS

much as the severity of the pathological condition is indicated by the retention of the non-protein nitrogen and creatinine and since these blood constituents increase as the blood dilution increases it follows that the determinations of changes in blood concentration under the experimental conditions may be taken as indication of the severity of the kidney lesion. It must also be quite evident that the degree of dilution of the blood observed is sufficient to account for a significant apparent anemia. In how far this factor may be applied clinically to the occurrence of anemia in nephritis remains a subject for future investigation.

SUMMARY

There is a close relationship in uranium nephritis between the degree of retention of non-protein nitrogen and creatinine and blood concentration, the greater the retention the more dilute becomes the blood. It is possible that changes in blood concentration may be employed clinically as an indication of the severity of a nephritic condition; and it is possible that this factor in part at least is responsible for the anemia observed clinically at times in nephritis.

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THE ASSOCIATION OF HYPERNEPHROMA WITH TUBEROSE BRAIN SCLEROSIS AND ADENOMA SEBACEUM

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Occasionally, a combination of several diseases takes place with such regularity as to preclude the possibility of a coincidence. This applies to the association of three maladies first described forty years ago by Hartdegen (1), and later on by Bourneville (2), Harbitz and Fischer. These observers noted that in the condition known as tuberose brain sclerosis, there was frequently present a peculiar skin eruption known as adenoma sebaceum. It was only after making careful autopsy studies of patients who had died of brain sclerosis, it was recognized that, in a large number of instances, there was also found, besides the brain sclerosis and skin eruption, tumors of the kidney, either single or multiple. At first, it was considered more or less of a coincidence that these three conditions should occur together. As more and more cases were studied, both from a clinical and pathological point of view, the number in which all three affections were found reached such a high percentage that the triad as a clinical entity was recognized. Up to the year 1910, sixty cases had been collected from the literature, comparatively few have been reported since. This disease-complex has been so ably described that a diagnosis intra-vitam can now be made in the majority of cases.

Incidence. Practically all cases occur within the first two decades, an occasional one having been reported in the third decade. The brain lesion, known as tuberose brain sclerosis, manifests itself clinically by delayed mentality or by varying

degrees of imbecility and idiocy. The young patients are very prone to epileptiform seizures. Pathologically, there are no evidences of any inflammatory condition in the brain or vessels, but scattered over the surface of the cortex and upper medullary layers are smooth, gray white, nodular sclerotic thickenings, 1 to 2 cm. in circumference.

Tumors of the kidney have been found in over 80 per cent of the cases. The percentage according to some authors is greater than this, for it was some time before their association was recognized, and as a result, many cases were overlooked. In later years, the cases coming to autopsy have been more carefully examined, and almost invariably, kidney tumors existed. In 26 cases autopsied since 1906, renal growths occurred 21 times or in four-fifths of the cases. Clinically, the tumors in the majority of instances are benign in character and produce few or no symptoms. The growths are very often small, probably due to the fact that they are discovered early in the course of their development, and as a result, cannot be palpated.

Pathologically, the tumors show the following characteristics. Practically all are found in the kidney cortex and are sharply defined from the surrounding kidney tissue. As a rule, they have no distinct capsule. Their size varies from tiny growths to those as large as grape fruits. The following types have been found: angio-scaroma, myoscaroma, liposcaroma, myolipoma, fibrolipoma, and hypernephroma. Metastases are rare, probably on account of the fact that the patients die young, when the growths are seen early in their development. Very frequently the tumors have been bilateral.

The skin condition, known as adenoma sebaceum, is characterized by the appearance of small yellow white nodules which resemble small tumors. Some are pointed, others half pointed, and about the size of a pin's head. These lesions have a characteristic distribution, generally appearing on the face, especially in the naso-labial folds, and on the surrounding portions of the nose, cheeks and forehead. The nodes show no inflammatory changes, but are adenomatous in character and take origin from the sebaceous glands and epithelium of the hair follicles. It is

an interesting fact that in over half of the cases in which this skin disease appears, the patients are either idiots, imbeciles or epileptics. Rhabdomyomata have been found associated 8 times in 60 cases of tuberosc brain sclerosis. The prognosis is bad, the majority of the patients dying within the first two decades of life, either from tuberculosis or as a result of their renal neoplasms.

The etiological factor has not been determined. Some observers have regarded it as an endocrine disturbance, others as a congenital anomaly. In this connection it may be of interest to note that in idiots, the most highly differentiated organs suffer most injury. This is certainly the case in this condition where the lesions are found in the brain, kidneys and skin.

The following case, which may be taken as a typical instance of this combination of diseases was observed in 1918. Of especial interest is the fact, that the diagnosis of this disease was made by the attending dermatologist of the hospital, Dr. Goldenberg, who was called in for an opinion of the skin condition. After examining the peculiar skin eruption and noticing the dull apathetic expression of the patient and without resorting to abdominal palpation, Dr. Goldenberg inquired whether the boy had a kidney tumor. Up to this time, we were not aware of the fact that these three conditions constituted a clinical entity.

A. W., male, age ten years. Admitted to Mt. Sinai Hospital April 19, 1918.

Family history. Patient is second of four children; others are well; no tuberculosis or familial diseases.

Past history. Patient first had convulsions at two and one-half years since then have been repeated at least a half dozen times each year. Measles at seven years. Has been mentally deficient since early childhood, so much so that parents were forced to remove him from school on account of his inability to keep up with even the lowest grade classes. During the past year has had peculiar athetoid movements of hands. Has had eruption on face for a number of years.

Present illness. Began about a month before admission, with weakness, lassitude and loss of appetite. The boy did not play around as

usual and was finally put to bed for a week. About ten days ago, he first complained of pain in the right loin, which has persisted up to the present time. Has had fever as high as 104° for past three days; bowels constipated. No urinary symptoms.

Physical examinations. Demonstrates a well nourished boy who has a dull apathetic expression. His answers to questions shows a decided state of mental inferiority. This is a peculiar looking eruption over the face, nose, cheeks and forehead. The eruption consists of innumerable tiny pin head sized nodules, yellowish to dark red in color. Abdominal examination demonstrates a hard nodular mass, the size of a grape fruit, in the right loin. This mass is easily balloted from the loin and is slightly tender on pressure. The rest of the physical examination is negative. The urine is clear; acid; no albumen; specific gravity 1.024; occasional pus cell; no blood.

Red blood count.....	5,000,000
White blood cells.....	41,000
Polynuclears.....	88 per cent
Hgb.....	65 per cent
Von Pirquet.....	(Negative)

X-ray of urinary tract demonstrates a large shadow which might be a considerably enlarged kidney occupying the entire right renal region. Temperature on admission 103° —fluctuated between 102° and 104° , up to day of operation, about ten days later.

Cystoscopic examination. On account of the small urethra, only an observation cystoscopy could be carried out. The bladder was found negative; the right ureteral orifice was swollen. Indigo-carmin appeared from the right kidney in weak concentration in thirty-five minutes observation; good deep blue from the left side in fifteen minutes. A diagnosis of renal neoplasm was made and operation was advised.

Operation. Right lumbar incision, revealing a large soft kidney; typical nephrectomy. Kidney removed was three times the normal size, very soft and friable, with necrotic infected areas. Pathological report, hypernephroma. Uneventful convalescence, temperature reaching normal soon after operation.

Examination. February 20, 1922, more than three years and a half after operation. The boy is in excellent physical condition, with no evidences of recurrence or metastases. The mental condition remains practically unchanged. Epileptiform convulsions are becoming more frequent and last longer. The rash on the face has not undergone any changes.

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EXTRAPERITONEAL PELVIC SUPPURATION IN THE MALE¹

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The purpose of this paper is to discuss pelvic suppuration of genital origin in the male. The condition would seem to be rare, if one may judge from the paucity of writings on the subject. A great deal has been written on the genito-urinary complications of pelvic abscesses of appendiceal or sigmoidal origin, especially as regards vesico-intestinal fistulae. There seems to be a popular misconception however, that these fistulae usually result from malignancy primary in the intestinal tract. The fallacy of this is shown in the large series of cases recently reported by Sistrunk and Sutton. It is also of interest to quote from a monograph by Cripps published in 1888, where it is stated that "Research into the subject shows indisputably that entero-vesical fistulae are far more commonly the result of inflammatory mischief than due to perforation from cancerous growth."

The condition to which we refer is characterized by abscess formation in the extraperitoneal retrovesical or perivesical spaces, which does not, so far as we know, tend to form fistulous communication with the intestinal tract, except in rare instances by direct ulceration into the rectum, and the primary origin of which is often a matter of conjecture. We believe that at least some of these cases represent a pathological, if not a clinical entity, and that the primary infection is resident in the seminal vesicles.

It is conceivable that an abscess primarily genital in origin and extraperitoneal in position, might form adhesions secondarily

¹ Read before the Philadelphia Genito-Urinary Society in October, 1921.

with some portion of the intestinal tract and ulcerate eventually into both the bladder and intestine, with the production of an entero-vesical fistula. The evidence, both clinical and operative, is contrary to this hypothesis, the latter being especially significant for the reason that in a large percentage of cases, the primary lesion has been demonstrated to be either a sigmoidal diverticulitis or an appendicitis, or other lesion, inflammatory or cancerous, primary in the intestinal tract. It is especially significant that the writers who have taken the greatest pains to determine the primary cause of entero-vesical fistula do not record instances in which fistulae of this sort have developed from infections primary in the genital tract, except the infection be tuberculous, or the fistula an ordinary urethro-rectal one resulting from the perforation of a prostatic abscess into the rectum.

Many causes of perivesical and retrovesical suppuration are recognized, the principal ones being periprostatitis and perivesiculitis, either venereal or nonvenereal in origin. Other causes to be considered are:

1. Infections following surgical injuries and operations. Among the rarer causes are the transrectal or intravesical insertion of radium needles in the treatment of prostatic or vesicular carcinoma; and the transperineal injection of medicines into, or the aspiration of pus from, the prostate gland.

2. Traumatic injuries: Incomplete extraperitoneal rupture of the base of the bladder with slow extravasation of urine; fracture of the pelvic bones associated with lacerations of the prostatic urethra permitting urinary extravasation; gunshot wounds.

3. Instrumental injuries to the bladder and deep urethra.

4. A non-traumatic group, comprising the majority of cases.

In addition to periprostatitis and perivesiculitis, the following causes are recognized:

- a.* Pericystitis associated with severe inflammations of the bladder. In this connection, it may be stated that pelvic abscesses arising from tuberculous cystitis are extremely rare.

- b.* Appendiceal abscesses, which are usually intraperitoneal, but which may develop from a retrocecal or subcecal appendicitis and point downward.

- c. Sigmoidal diverticulitis.
- d. Diverticulum of the bladder with diverticulitis, especially in cases associated with stone.
- e. Suppuration arising from infection of the pelvic lymphatics.
- f. Caries of the sacro-iliac bones.
- g. Secondary infection of dermoid or echinococcus cysts.

In the study of a given case of pelvic suppuration, each of the above predetermining causes must be taken into consideration. The primary source of the infection will still be in doubt after the most painstaking search in a considerable proportion of cases, in which event the possibility of metastatic infection from a distant focus must not be overlooked. In the majority of instances, the history of long standing genito-urinary infection, usually, but not always, venereal in origin, answers satisfactorily the question of the source of the micro-organisms.

The bacteria involved may be any one or a mixture of the common pus producing organisms, of which the colon bacillus is by far the most frequent. Uncomplicated gonorrheal infection is extremely rare, as is also suppuration due to the typhoid bacillus. Primary tuberculous infection of the prostate and vesicles with secondary invasion by the pyogenic organisms, undoubtedly explains a definite proportion of these cases.

To recapitulate: The condition to which we refer is characterized by the formation of extraperitoneal pelvic pus in the male, the source of which is usually determined by a process of exclusion to be seminal vesicular, which is not tuberculous in type, and which is remarkable clinically for the slow formation of the pus, which latter apparently shows little if any tendency to evacuate itself into the intestinal tract, but which may ulcerate into and discharge itself through the urinary bladder.

The first case which we have to report probably illustrates the pathology of the condition in its earliest stages:

Case 1. J. E., October 23, male, tailor by occupation, was referred by Dr. Markley Albright on June 3, 1921, with the chief complaints of "burning on urination" and "pain in the rectum."

The patient states that since childhood, he has had pain during urination "Just as if I had to force myself." He has been in the habit

of voluntarily interrupting the stream because of pain. Urgency is a prominent symptom, but there has been no frequency or hematuria. This condition continued without change until April, 1920, when, following catharsis with magnesium sulphate, he had an attack of acute urinary retention lasting sixteen hours, after which he emptied the bladder voluntarily. Since this time, he has had marked urgency and burning on urination, accompanied by moderate diurnal frequency and nycturia three times, together with severe pain in the lower back. He has had occasional night sweats and has lost 20 pounds in weight during the past year. Has been quite constipated during the past several years, requiring frequent cathartics. Has never had any urethral instrumentation.

Past medical history: Denies venereal diseases. Repeated attacks of acute tonsillitis.

Family history: Entirely negative. Wife and one child living and well.

Physical examination: Thin, anemic looking young adult male. No general abnormalities or skin lesions. Mouth: Teeth in fair condition; tonsils enlarged and diseased. Chest: Poorly developed; heart and lungs negative. Abdomen: Slightly scaphoid in contour; slight tenderness in hypogastrium on deep pressure; otherwise negative. External genitalia: Very slight thickening of globus minor of right epididymis; otherwise negative. Extremities and reflexes normal. Rectal examination: Prostate slightly if at all enlarged, slightly irregular in outline, not indurated and not especially tender. In the region of each seminal vesicle there is a large, lobulated, sausage-shaped mass approximately $1\frac{1}{2}$ inches in diameter. These masses are equal in size, extend upward and outward beyond the reach of the finger, and are of irregular consistence, but without areas of softening, and are extremely tender. The masses are separated by a distinctly palpable deep groove. The urine contained a large quantity of pus.

The patient was transferred to the Methodist Episcopal Hospital for further study where the following observations were made:

Temperature on admission: 98°; pulse 80; respiration 24.

Laboratory findings: Urine amber, slightly turbid, acid, specific gravity 1.011, faint trace of albumin, no sugar, pus plus, no tubercle bacilli found.

Phthalein test: First hour 60 per cent, second hour 35 per cent.

Blood examination: Hemoglobin 86 per cent; red blood cells 5,000,000; white blood cells 12,400.

Differential count: Polymorphonuclears 58; small lymphocytes 16, large lymphocytes 21; mononuclears 1; transitional 1; eosinophiles 1.

Blood sugar: 0.072 per cent. Blood urea: 10 mgms. per 100 cc.

Blood Wassermann: Negative.

The preoperative diagnosis in this case was bilateral seminal vesicular tuberculosis, probably with a superimposed and more active mixed infection.

Operation: June 11, 1921. Dr. Herman and Dr. Stuart. Gas and ether anesthesia. Young's perineal incision. Prostate small and densely adherent to rectum. A considerable quantity of recent exudate found posterior to prostate. Vesicles exposed after difficult dissection. These structures were found lying embedded in a thick mass of exudate, the latter forming the masses that had been felt per rectum. The vesicular walls were somewhat thickened and quite friable. The vesicles were mobilized from above downward and removed after ligation of their ducts. No apparent injury was done to the rectum or urethra during the dissection. A large drain was placed in each vesicular bed and the wound closed.

Pathological examination of the vesicles showed a simple inflammatory process without evidence of tuberculosis.

The day following operation, a urinary fistula developed; otherwise the convalescence was uneventful. He was discharged from the hospital July 9, 1921 with the incision closed except for a minute urinary fistula. The patient was seen again July 20, 1921, having had in the meantime an attack of acute tonsillitis. He was passing a large stream of urine without difficulty. Since then, he has gained 10 pounds in weight and is in good health except for the occasional leakage of a few drops of urine from the almost invisible fistula in the perineum. The urine is clear and his sexual power has returned. The prostate is normal to touch and there is merely a slight thickening in the vesicular areas. The prostatic fluid contains a few pus cells.

The primary source of the infection in this case is problematical, probably metastatic from the tonsils, but the pathology is illustrative we believe, of the initial steps in the development of the particular type of extraperitoneal pelvic suppuration with which we are now concerned. It is easy to conceive how the liquefaction of a considerable mass of exudate, such as was found in this instance, would lead to a formation of a large abscess, the latter tending to burrow in various directions, or to evacuate itself spontaneously into the rectum or bladder.

It is probable that resolution takes place in the vast majority of cases of perivesiculitis, leaving behind a residuum of chronic pathology confined for the most part to the vesicles. Such resolution is doubtless dependent here as elsewhere, in part at least, upon the ability of the regional lymphatics to limit the spread of the infection. In the exercise of this function, the



FIG. 1. CALCIFIED PELVIC (PARARECTAL) LYMPH NODES

The right seminal vesicle is apparently adherent to these nodes, thus explaining the pain on ejaculation and hematospermia of which the patient complained. The primary infection was, we believe, in the seminal vesicles (case 2).

lymph nodes may suffer considerable destruction and eventually become fibrosed or even calcified. Adhesions formed in this manner, may interfere seriously with the contractility of the seminal vesicular muscles and thus contribute to the incurability of certain cases of chronic vesiculitis. They may likewise interfere with the normal action of the intestinal (rectal) muscles.

We can visualize this sequence of events in a patient with calcified pararectal lymph nodes (fig. 1) who recently came to us complaining of pain in the right inguinal region, painful ejaculations, obstinate constipation and hemospermia. This history follows:

Case 2. J. W., white, admitted November 10, 1921. Chief complaint: Pain in the right inguinal region and bloody emissions. The patient contracted gonorrhea in 1912 which persisted without acute complications for two years. In 1916 he was treated for a stricture of large calibre. No treatment since 1916. For the past six months, he has had considerable pain on ejaculation and during the past four months has noticed blood in the seminal fluid. There is considerable fixed, bilateral lumbar pain and a dull pain in the right inguinal region. The pain on ejaculation is described by the patient as "a pulling or tugging as if something was trying to break away, or to force itself through too small an opening." This pain is felt in the perineum or rectum and suddenly disappears on ejaculation, to be followed by an aching sensation which persists for an hour or more. The urinary function is normal except for a somewhat contracted stream and slight dribbling. There is marked constipation with two bowel movements weekly; patient is a Pluto water habitué.

Past medical history: Typhoid and scarlet fever in childhood. Inflammatory rheumatism in 1907 and 1914. Denies chancre.

Family history: Negative.

Physical examination: Well developed and well nourished but slightly anemic and tired looking young adult male. Mouth: Tongue slightly coated. Tonsils have been removed but a small segment of the left lower pole remains. Teeth in very bad condition with several carious stumps and many bad fillings; X-Ray shows six apical abscesses. Heart normal in size, slightly irregular in action; muscles sounds good; rate 90; no murmurs detected. (The patient was examined by an internist in April, 1921, who made the following diagnosis: "Chronic endocarditis of rheumatic origin, resulting in mitral stenosis.") Abdomen: Slight tenderness on deep pressure in the loins; otherwise negative. Genitalia: Slight inguinal adenopathy; no scars on penis; no urethral discharge obtained. Testes and cords normal. Patient passes a fairly large urinary stream; urine slightly hazy and contains a few small shreds. The prostate is small, slightly irregular in outline and of normal consistence. The vesicles are palpable, smooth and soft but quite tender. Above the right vesicle there is an indefinite fullness.

The secretion contains large numbers of red blood cells, pus cells and a large extracellular diplococcus and a small bacillus. (Two months ago, the patient was told by another physician that the prostatic fluid contained the gonococcus; this we failed to confirm.) The gonorrhea complement fixation test shows a three plus positive reaction; the blood Wassermann test is negative. X-ray of chest, urinary tract and

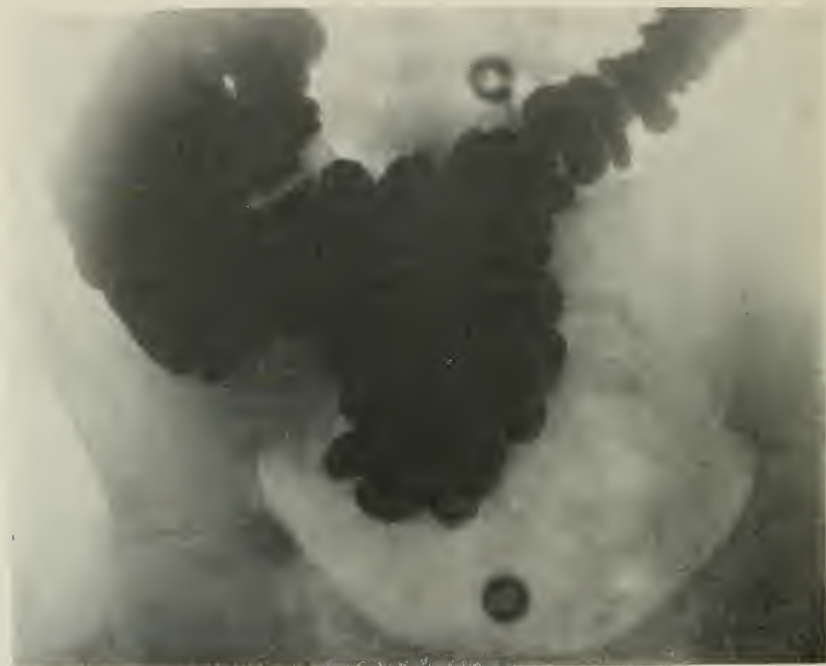


FIG. 2. PTOSSED TRANSVERSE COLON

The colon was adherent in the region of the calcified lymph nodes in the right side of the pelvis (see fig. 1). This explained the constipation of which the patient complained (case 2).

prostate negative. There is a peculiar shadow in the pelvis which the roentgenologist describes as follows: "With the patient in the supine and prone position, there is a shadow of a foreign body of well marked density and mottled appearance, ovoid in shape and 3 by 4 cm. dimensions, occupying a position on the right side and at the level of the lower end of the sacrum. This shadow has a distinct cleft through its middle portion. There is a much smaller shadow of the same shape

and physical characteristics occupying a position just mesial to the right sacro-iliac joint. Both kidney shadows are normal in size and density. Lower pole of the left is a trifle below the level of the transverse process of the third lumbar vertebra, and the lower pole of the right kidney appears to be on a level with the upper aspect of the transverse process of the third lumbar vertebra. I believe there is a slight fixed rotation of the fourth lumbar vertebra toward the right side. There is no evidence of prostatic calculus. The shadow mentioned above is that of a calcified lymph node."

The gastro-intestinal X-ray studies in this case show periduodenal adhesions with dilatation of the first segment of the duodenum and marked ptosis of the cecum and colon. The latter is situated in the pelvis and is fixed by adhesions in the region of the calcified nodes. The cecum is also ptosed and sharply angulated (fig. 2).

The proctoscopic examination revealed no constriction of the rectum but the lower segment was somewhat inflamed.

It seems reasonable to conclude that the chronic invalidism in this instance is due in part at least, to an ancient gonorrheal seminal vesiculitis and perivesiculitis, the dissemination of the latter having been limited by the defensive activities of the pelvic lymphatics.

The third case represents what we consider to be a later stage of a condition similar to that found in case 1 with the difference that the source of the bacteria is evidently a long continued genito-urinary infection. In this instance, the natural defensive powers have failed, with perivesicular abscess as the result.

Case 3. A male Italian of thirty years, a laborer by occupation, unmarried, was admitted to the Pennsylvania Hospital October 27, 1921, on the surgical service of Dr. John Gibbon. The chief complaints were frequency and urgency of urination with terminal hematuria and lower abdominal pain. The trouble dates from March, 1920, when the symptoms of acute posterior urethritis developed. We have found it impossible to determine whether these symptoms came as a complication of acute gonorrhea; in fact the patient denies all venereal diseases. Despite treatment by several physicians and in several hospitals, the condition increased in severity until in October, 1921, he was voiding twenty to forty times daily and ten to twelve times each night with

great urgency and terminal bleeding. He was cystoscoped on October 24 by an outside physician, who reports to us that the examination was unsatisfactory because of extreme irritability of the bladder. The patient was immediately referred to the hospital where the following observations were made: Moderately emaciated individual with temperature 99.5°, pulse 90, and respiration 20. General physical examination was negative except for marked pyorrhea and carious teeth. There was a sausage-shaped, firm and tender mass underlying the right inguinal canal extending outward and upward to a point above the anterior iliac spine. The rectal examination showed a small, slightly irregular prostate and a large pelvic mass. The latter seemed to take origin from the right seminal vesicle, was sausage-shaped and extended in an upward and outward direction beyond the reach of the finger. By bimanual examination, the pelvic and abdominal masses were found to be continuous. The left vesicle was enlarged, soft and tender.

Laboratory findings: Urine contained blood, some pus and a trace of albumin. Phthalein elimination was 30 per cent in two-hour period. Blood urea content was 20 mgms. per 100 cc. The X-ray examination showed a peculiar distribution of gas shadows in the right pelvic area and extending upward in the line of the abdominal mass (these shadows were probably caused by air which had entered the abscess cavity during the first cystoscopic examination).

On October 29, a cystoscopic examination (Dr. Herman) showed the following: Bladder filled with thick muco-purulent blood-tinged urine. Bladder mucosa covered with thick, almost gelatinous muco-pus, so that the cleansing process consumed considerable time. The mucosa shows comparatively little congestion laterally and on the vault. The right ureteral orifice is only slightly inflamed, while the left orifice cannot be seen on account of a mass of tenacious muco-pus. About 1 inch above the site of the right ureteral orifice and in the midline of the bas-fond, there is a large ragged and irregular crateriform ulcer or fistulous opening about 1 inch in length and $\frac{1}{4}$ inch in width. The opening admits a catheter for a distance of about $\frac{1}{2}$ inch and pressure per rectum on the mass causes large quantities of thick pus to enter the bladder through the fistula. The appearance of the fistula is that of a chronic condition and does not at all suggest recent traumatic injury. Cystoscopic diagnosis: Extraperitoneal pelvic abscess originating from the right seminal vesicle with ulcerative communication with the bladder.

The facts enumerated were carefully considered by Dr. Gibbon and the writer and it was decided to drain the abscess cavity through a small abdominal incision. Operation by Dr. John Gibbon November 2, 1921. Small extraperitoneal incision above and parallel with the right inguinal canal. The abscess cavity was explored and found to extend downward into the pelvis. A small quantity of thick sanguinous mucus with a faint colon odor was evacuated. (The culture of the pus showed the colon bacillus.) A rubber tube was inserted for drainage. By the following day, a urinary fistula had developed; this persisted until the patient's death several months later. The post-operative course in this instance would seem to indicate that the infection was primarily genito-urinary in origin.

We realize that the evidence to support our belief that this was primarily a perivesicular infection, is largely circumstantial. The possibility of instrumental injury cannot be eliminated with certainty, nor can we rule out the possibility of primary appendicitis or adenitis of the pelvic nodes. The weight of evidence seems however, to support the theory that we were dealing with a primary infection of the right seminal vesicle with perivesicular abscess and secondary rupture into the urinary bladder. The history of the case is certainly not that of appendicitis or other intraperitoneal lesion. There was a long standing genito-urinary infection of a progressive type characterized over a long period of time, by severe symptoms of posterior urethral irritation. Examination made five days after the first cystoscopic examination revealed the presence of a large pelvic mass beginning in the region of the right seminal vesicle and extending upward beneath the right inguinal canal. The cystoscopic examination indicated that the fistula in the bladder was an ancient process and not the result of recent injury. Finally at operation, the abscess was found to be extraperitoneal in position and its contents lacked the peculiar malodorous characteristics of appendiceal abscess, while incision was promptly followed by the development of a urinary fistula and the absence of a fecal fistula. All of these facts leads us to the conclusion that this is an instance of perivesicular abscess of seminal vesicular origin.

The fourth case illustrates a still later stage of this same suppurative process, the exudate having progressed to complete liquifaction with the development of a large abscess.

Case 4. W. S. J., male, age thirty-seven, was admitted to the medical service of the Methodist Episcopal Hospital of Philadelphia June 6, 1921. His chief complaint on admission was shooting pains in the legs. The patient stated that he was perfectly well until about ten days before admission, when he was suddenly seized with shooting pains in the legs. This was associated with incontinence of urine at night and great frequency in the day time. He also had considerable difficulty and pain on urination. The attack came suddenly while he was at work; he went to bed and had a fairly comfortable night but next morning had a high fever. Soon thereafter he developed a cough with considerable expectoration but no hemoptysis. The bladder symptoms were slight on admission to the hospital; he had at this time a temperature of 103°F., a pulse rate of 100 and a respiratory rate of 24.

Past medical history: Measles in childhood. No history of scarlet fever or diphtheria. Gonorrhea 12 years ago without complications. Syphilis in 1910, for which he was treated with mercury for a period of three years. He has had one injection of salvarsan. No treatment since 1913. No history of typhoid fever or pneumonia. He was operated upon in 1914 for acute appendicitis with drainage, and following this, had acute retention of urine, for which he was *catheterized*.

Sexual history: Married. Wife has given birth to two healthy children who are alive and well. No miscarriages. Both children have been born since the father developed syphilis. Patient is a mechanic. No alcoholic history.

Family history: Negative.

Physical examination: On admission, inspection shows a somewhat emaciated adult male. General examination negative.

Laboratory examinations: On admission, the urine examination was as follows: Cloudy, specific gravity 1.009, faint trace of albumin, loaded with pus. On June 23, the blood was found to contain 23,800 leucocytes with 84 per cent of polymorphonuclears, the hemoglobin was 90 per cent, the erythrocytes 5,060,000. Throughout the patient's stay in the medical service, there was a marked pyuria and leucocytosis. On June 23, the 'phthalein output was practically nil. Culture of the urine on July 5 showed the bacillus coli in pure culture; examination

for the tubercle bacillus was negative. Widal test for typhoid and paratyphoid was negative. The X-ray showed a pre-tubercular type of chest with involvement of both apical regions. The perivertebral branch distribution is the most involved. X-ray of the spine showed osteoarthritic changes, the first and second lumbar vertebrae being joined together by a band. No evidence of urinary calculi. The Wassermann test was negative.

The treatment consisted of urinary antiseptics, bladder lavage and an autogenous vaccine the initial injection of which was given, begun July 18 (bacillus coli).

The patient progressed from bad to worse with gradually increasing loss of weight, irregular fever and loss of bladder and bowel control.

On August 8, he was examined urologically and the following notes were made. "Prostate enlarged, soft and tender. Both seminal vesicles are enlarged and boggy. The greatest enlargement is laterally but extends beneath the trigonum. There is a hypogastric mass the size of a grape fruit, which does not disappear on catheterization. I believe that this man has pus in the pelvis (extra-peritoneal). Cystoscopy is contraindicated. Would advise perineal section. The patient has fixed unequal pupils and all reflexes are missing with the exception of the biceps. No Babinski or ankle clonus." At this time, his blood contained 43,600 leucocytes. The spinal fluid examination showed a cell count of 6 (polymorphonuclear 60 per cent lymphocytes 40 per cent). Globulin was positive, Fehling's reduced, the Wassermann of the spinal fluid was negative.

The patient was transferred to the urological service and operated upon August 19, 1921. The operative notes follow: Young's incision. Membranous urethra surrounded by exudate. The tissues are friable. In attempting to expose the apex of the prostate on the right side, a large abscess was broken into and about 1000 cc. of very malodorous pus evacuated. The pus was mixed with urine and the abscess cavity apparently communicated with the bladder cavity. The suprapubic swelling disappeared when the abscess was drained. Pus was also found in the left vesicular area. The urethra was opened in the mid-line during the dissection. A rubber tube was placed in the bladder through the urethrotomy wound. The abscess cavity was drained with tubes and cigarette drains.

The patient improved slowly after operation and was discharged September 17, 1921. On September 9, 1921, the urethra admitted a sound (size no. 28 F.); on September 16, 1921, some urine was voided

normally. A small fistula persisted in the right arm of the perineal incision. This admitted a filiform guide which apparently entered the bladder cavity. After the introduction of the filiform, the fistula closed completely.

During the past month or more, the patient has nocturnal incontinence and some frequency during the day. He is otherwise in good condition, his weight having been restored almost to the normal.



FIG. 3. CYSTOGRAM SHOWING DISTORTED BLADDER WITH MANY SMALL DIVERTICULAE AND DILATATION OF THE DEEP URETHRA IN A TABETIC

The cystogram was taken several months after operation for a large perivesicular abscess (case 3).

The question that now concerns us is whether the incontinence is a manifestation of cerebrospinal syphilis or the result of surgical or inflammatory injury to the sphincter mechanism of the bladder. The fistula, which is now closed, leaked urine constantly which fact led us to the conclusion that we were dealing with a vesico-perineal fistula and not a urethro-perineal one. This conclusion is open to grave doubt, because

the cystogram shows paralysis of the internal sphincter as is evidenced by the presence of a bladder neck (fig. 3). This picture shows abnormalities that are highly suggestive of the tabetic bladder. Note the irregularity in outline, the presence of numerous small saecules and the wide open internal sphincter. Cystoscopic examination (December 16, 1921) showed a normal mucosa covering many fine trabeculations highly suggestive of the tabetic bladder. The differential diagnosis is of the greatest importance for if the condition is a mechanical one, it might be corrected by a plastic operation on the internal sphincter muscle; if the paralysis is tabetic, operation is obviously contraindicated and the prognosis is very bad indeed. Notwithstanding the negative serological examinations of the blood and spinal fluid, we believe that the evidence is sufficient to justify the diagnosis of tabes.

In this connection, it may be of interest to analyze several of the cases reported by Schmidt of Chicago in 1911, which are similar in symptomatology, but which present marked differences in physical findings.

Case 1 (Schmidt). A married man of forty-five with eight healthy children and no history of venereal infection, had had slight symptoms of gastro-intestinal derangement for five years. His chief complaint on admission to Alexian Brothers Hospital, Chicago on May 13, 1909, were lower left abdominal discomfort and frequency, urgency and tenesmus of one weeks duration. On admission, temperature 101.5°, pulse 110, respiration 18. Leucocytes 14,400. Physical examination revealed a mass in the lower abdomen extending from the pubes to a point well above the umbilicus. The mass was neither painful nor very tender and there was no muscular rigidity. Catheterization brought away 750 cc. of normal clear sterile urine, after which a residual mass extending two and one-half inches above the pubes was noted. Rectal examination showed no abnormality in the prostate or vesicles but these structures were pushed down by a fluctuating pelvic mass situated more to the right of the mid-pelvic line. Cystoscopic examination was negative except for slight congestion of the bladder mucosa.

Through a perineal incision, 300 cc. of bloody pus was evacuated, the abscess having been opened into between the seminal vesicles. Recovery was prompt and the convalescence uneventful.

Case 2 (Schmidt). A man thirty-two years of age with the history of gonorrhea two years previously which was uncomplicated and ap-

parently cured in six weeks, was suddenly taken one week before admission with an acute intestinal derangement. The attack was characterized by diarrhea and rectal tenesmus and after five days by painful and frequent urination. The general physical examination was negative except for slight emaciation and the presence of a large tender mass in the hypogastrium. On catheterization 500 cc. of clear sterile urine was obtained. The rectal examination as in the preceding case, revealed the presence of a large fluctuating mass above and behind the bladder; the prostate and vesicles were normal. In this instance, 500 cc. of blood and pus were evacuated through a perineal incision and the patient recovered promptly.

In neither of these cases was the primary source of the infection proved beyond the question of a doubt, although the abscess in each instance was thought to be of appendiceal origin. Neither the clinical histories nor the operative findings definitely incriminated the appendix. The rectal findings eliminated the prostate and vesicles as foci of infection while the urine was sterile, which facts would seem to denote the normality of the lower genito-urinary tract. In addition, the cystoscopic examinations were negative.

We are not convinced that the abscesses in these patients may not have arisen as the result of metastatic infection from distant focal lesions. In both of these cases and in the first and third of our own cases, operation with drainage through the perineum resulted in cure.

If we may be allowed to judge from so limited an experience, we would advise the perineal approach to abscesses of this type unless it can be proved beyond a reasonable doubt that the supuration takes origin from an intraperitoneal organ, or structure. Many of these patients are in a desperate condition when they come to operation, as was our third case, so that the least amount of operating that will secure proper drainage is the best surgery.

THE DEVELOPMENT AND SURGICAL IMPORTANCE OF THE RECTOURETHRALIS MUSCLE AND DENONVILLIERS' FASCIA

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The foundation of all perineal surgery is an exact knowledge of the rectourethralis muscle and Denonvilliers' fascia. Hazy ideas of anatomical relations are indirectly responsible for most of the criticisms leveled at the perineal prostatectomy operation, since failure to properly divide the rectourethralis muscle may result either in urinary incontinence or a rectourethral fistula. The descriptions of the rectourethralis muscle in the literature are very vague and indefinite, hence inexperienced surgeons because of the small operative field and consequent narrow margin of safety, occasionally have trouble in successfully exposing the prostate.

Denonvilliers' fascia, which lies between the rectum and the prostate, can be split into two layers, and as a result the didactic statement that it represents a fusion of the layers of the fetal peritoneum has been generally accepted. At the suggestion of Hugh H. Young this study was made to see if there was any scientific basis for that theory. The work was begun at the Brady Urological Institute, Johns Hopkins Hospital, and completed in the Department of Urology, University of California.

HISTORY

Denonvilliers (1), in 1836, enunciated the hypothesis that the center or nucleus of the perineum is a prerectal raphé or "aponeurosis prostato-peritonele." This fibrous plane is triangular in shape with a truncated apex which blends with the

superior layer of the triangular ligament, while the base is adherent at the top to the inferior face of the peritoneum thereby helping form the rectovesical cul-de-sac. The posterior layer is in contact with the rectum, to which it is joined with very loose cellular tissue, while from the superior face arise dense cellular elongations which envelope the seminal vesicles, vasa-deferentia and inferior extremities of the ureters.

In 1899, Cuneo and Veau (2) went a step further and stated that the prostato-peritoneal aponeurosis of Denonvilliers was formed by a fusion of the fetal peritoneum of the rectovesical cul-de-sac, the two peritoneal layers combining and forming an aponeurotic sheet with a complete correspondence of the arrangement of the peritoneum in embryos of both sexes. Even if the original fused layers disappeared they made the frame work for later layers of fibers. As proof of this primitive fusion they called attention to evidences of incomplete fusions such as vesico-seminal cysts, perineal hernias and the cul-de-sac of Douglas in the female.

The following year Proust (3) stated that while the ideal scheme was to admit the existence of a prerectal fascia forming a nucleus of the perineum, as suggested by Denonvilliers (4) the hypothesis unfortunately could not be reconciled with surgical anatomy, for while it was easy to separate the coverings of the prostate into anterior and posterior layers it was most difficult to peel out the seminal vesicles, bladder and rectum. Zuckerandl (5), Dixon (6, 7), Henle (8), Moullin (9, 10), Waldeyer (11), and Richardson (12) agree in general with this view.

The existence of the rectourethralis muscle has been ignored by most anatomists and those who mention it vary greatly in their descriptions, as shown by the writings of Roux (13), Albarran (14, 15, 16), Fischer and Orth (17), Delbet (18), Proust (19, 20, 21), Walker (22, 23), and Jackson (24).

MATERIAL AND METHODS

The material used for microscopic study is indicated in the accompanying table and consists of serial sections of human embryos obtained through the kindness of Director George S.

TABLE 1
Specimens studied microscopically

CROWN RUMP LENGTH	CARNEGIE INSTI- TUTE NUMBER	ESTIMATED MEN- STRUAL AGE	SEX	OF THICKNESS SECTIONS	DIRECTION	STAIN	SOURCE
<i>mm.</i>		<i>weeks</i>		<i>microns</i>			
18.5	5	7	Not deter- mined	20	T	Carmine	Carnegie
15.5	390	6	Not deter- mined	50	S	H. and E.	Carnegie
19.8	1108	7	Female	40	T	H. E. Au. and Or. G.	Carnegie
20.0	22	7	Male	50	T	Carmine	Carnegie
20.0	460	7	Female	40	T	H. and E.	Carnegie
20.0	462	7	Male	40	T	Cochineal	Carnegie
22.0	635b	7	Male	50	T	Cochineal	Carnegie
23.0	903c	7	Not deter- mined	40	T	Cochineal	Carnegie
25.0	584a	7	Male	50	S	Cochineal	Carnegie
26.0	405	8	Male	40	S	Cochineal	Carnegie
26.0	895	8	Male	25	T	Cochineal	Carnegie
26.0	464	8	Male	100	S	Cochineal	Carnegie
27.0	875	8	Male	40	S	Cochineal	Carnegie
27.0	1458	8	Male	50	S	H. E. Au. and Or. G.	Carnegie
30.0	75	9	Male	50	S	Cochineal	Carnegie
33.0	145	9	Male	50	S	Cochineal	Carnegie
37.8	1161	10	Male	50	T	H. E. Au. and Or. G.	Carnegie
39.0	2514	10	Female	50	T	Cochineal	Carnegie
40.0	224	10	Male	50 and 100	S	Cochineal	Carnegie
46.0	1686	10	Male	100	S	H. E. Au. and Or. G.	Carnegie
52.0	448	11	Male	25 and 100	S	Cochineal	Carnegie
67.0	1656	12	Male	200	S	Cochineal	Carnegie
80.0	34	13 $\frac{1}{2}$	Male	50	T	Cochineal	Carnegie
80.3	768c	13 $\frac{1}{2}$	Male	6	T	H. and E.	Carnegie
130.0	1018	17	Male	50	T	H. and E.	Carnegie
161.4	1049	20	Male	40	T	H. and E.	Carnegie
169.0	2577	20	Female	100	T	H. E. Au. and Or. G.	Carnegie
176.0	2531	21	Male	100	T	H. E. Au. and Or. G.	Carnegie
210.0	2402	24	Male	100	T	H. E. Au. and Or. G.	Carnegie
221.0	1172	25	Male	15	T	H. and E.	Carnegie
253.0	2375	28	Male	100	T	H. E. Au. and Or. G.	Carnegie

Streeter from the collection of the Carnegie Institute of Embryology. Microscopic measurements were made with a Spencer ocular micrometer calibrated with a Zeiss micrometer stage objective.

Specimens of the rectourethralis muscle were obtained at operation, sectioned and stained with differential stains.

The macroscopic investigations consisted of dissections of both preserved and fresh cadavers of infants and adults.

A glass model was constructed of the pelvis of a seven-months fetus, cut transversely in sections 100 μ thick (specimen 2375, Carnegie Institute of Embryology). An Edinger projection apparatus was used, and the sections traced directly on glass plates by means of various colored Higgins inks. Distortion of the model was prevented by keeping the magnification ($\times 6.6$) in proportion to the thickness of the sections. The glass plates were then stacked, divided into packs about 2 inches thick and bound firmly with adhesive plaster. When mounted in a frame with electric lights behind them they appeared as colored gelatin molds in a glass case. A preparation of this kind is far superior to a wax model for perineal studies, as it gives a transparent presentation of an entire region, in this model showing ten structures and their relationships, instead of an opaque representation of a single organ.

EMBRYOLOGY OF THE PERINEUM

The primitive pelvis is divided into a ventral and dorsal half by the fusion of the two urogenital folds which unite throughout their whole length in the median line (fig. 1). This frontal partition is termed the genital cord (25) and appears in embryos between 19.4 and 20 mm., and when it fuses with the floor of the body cavity the partition is complete. It was formerly believed that sexual differences appeared with the formation of the genital cord, but Spaulding (26) has recently shown that they are present from the beginning. In females there is a distinct vesico-uterine pouch between the genital cord and the bladder, while in males the mesonephric folds approach one another in the median line and unite at once with the wall of the

bladder, the forerunner of the vesico-seminal vesicle pouch occurring as a very shallow depression. In a 37.8 mm. embryo the pouch was only 400 μ deep.

The coelom is lined with a layer of mesothelium which covers the loose mesenchyme tissue. This is the primitive peritoneum,

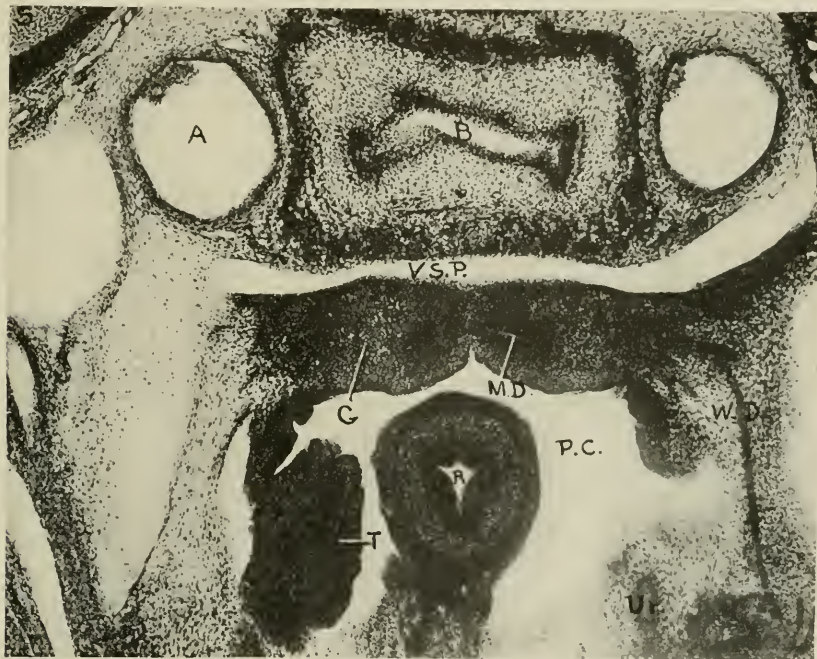


FIG. 1. TRANSVERSE SECTION OF PELVIS 37.8 MM. HUMAN EMBRYO

Showing the fusion of the genital ridges with the formation of the vesico-seminal pouch. *R*, rectum; *S*, symphysis pubis; *B*, bladder; *A*, umbilical artery; *G*, genital cord; *WD*, Wolffian duct; *MD*, Mullerian duct; *Ur*, ureter; *T*, testis; *P.C.*, peritoneal cavity; *VSP*, vesico-seminal pouch. (Embryo, Carnegie Institute 1161, slide 67, row 2, section 3.) $\times 54$.

which is replaced later by mesothelial pavement (epithelial) cells, supported by a basement membrane of connective tissue. With the formation of the genital cord the peritoneum passes over the bladder, dips into the vesico-uterine or vesico-seminal vesicle pouch and then continues down over the dorsum to the floor of the perineum and passes up about the rectum forming

the rectovesical pouch. With the development of the fetus this becomes compressed antero-posteriorly and relatively shallow because of the approximation and fusion of the layers. There is a marked increase in the amount of undifferentiated mesen-

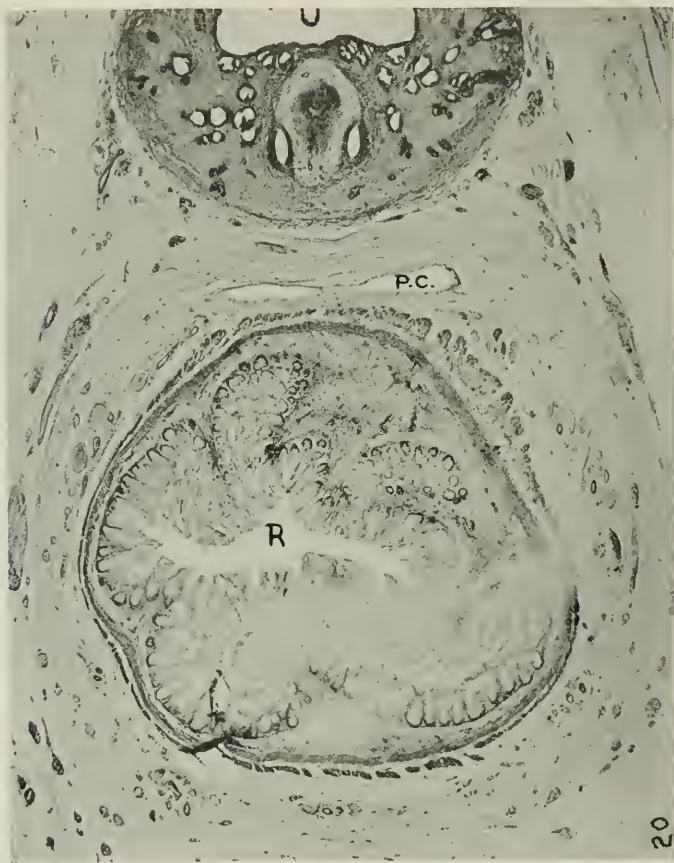


FIG. 2. TRANSVERSE SECTION THROUGH MOST DEPENDENT PORTION OF PERITONEAL CAVITY OF 161.4 MM. HUMAN EMBRYO

Surrounding the rectum is a condensation of connective tissue forming a cuff, in which the peritoneal cavity ends. The bottom of the utricule appears as a mass of elastic tissue with the ejaculatory ducts at the sides. The condensations of connective tissue between the prostate and the rectum represent the two layers of Denonvilliers fascia. *U*, urethra; *PC*, peritoneal cavity; *R*, rectum. (Embryo, Carnegie Institute 1049, slide 32, section 1.) $\times 17$.

chyme cells in the rectovesical space with definite condensations about the prostate and rectum, which often forms a cuff about the latter (fig. 2) enclosing the two layers of fetal peritoneum. These layers always lie closer to the rectum than to the bladder.

The rectovesical pouch, which extends to the floor of the perineum in a 15.5 mm. embryo, reaches just below the level of the



FIG. 3. SAGITTAL SECTION OF 25 MM. HUMAN EMBRYO

Showing a raphé formed by the fused layers of fetal peritoneum. The future muscles of the region are represented by the condensations of loose mesenchyme tissue; the raphé lies much closer to the rectum than to the site of the prostate. *U*, urethra; *R*, rectum; *PC*, peritoneal cavity; *ED*, ejaculatory duct. (Embryo, Carnegie Institute 584a, slide 14, row 1, section 1.) $\times 54$.

verumontum in a 46-mm. specimen, at 80 mm. it ends directly beneath the orifices of the ejaculatory ducts, and at 210 mm. the level is the same, but at 240 mm. the base reaches only to the middle of the seminal vesicles. In many of the specimens studied the peritoneal pouch is asymmetrical being slightly deeper on one side than the other.

When the peritoneal layers fuse, the mesothelium is absorbed and disappears leaving only a bed of mesenchyme. In one 25 mm. embryo there was an apparent raphé (fig. 3), as the absorp-

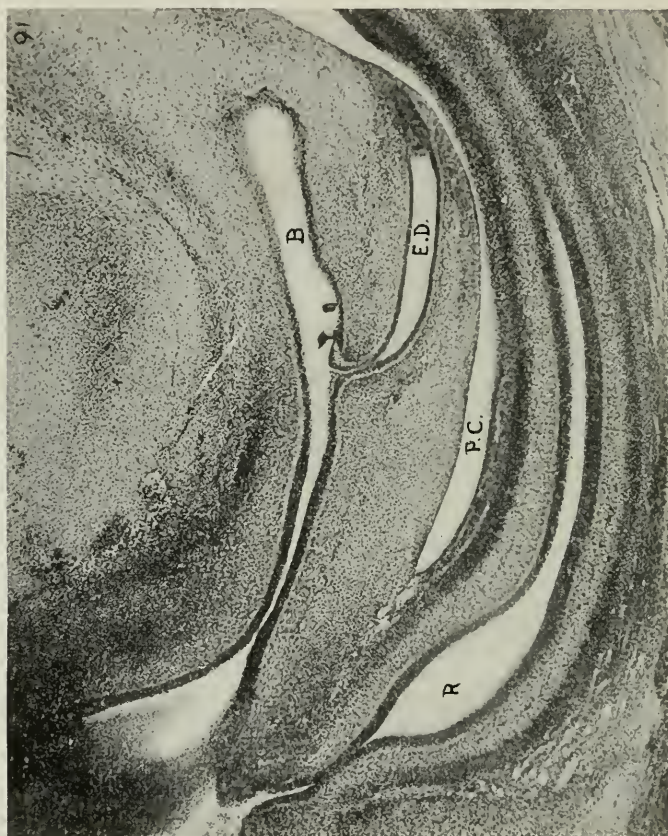


FIG. 4. SAGITTAL SECTION OF 26 MM. HUMAN EMBRYO

Showing incomplete absorption of fetal peritoneal layers with formation of "cysts." The beginning of musculature formation is well advanced. *R*, rectum; *PC*, peritoneal cavity; *B*, bladder; *ED*, ejaculatory duct. (Embryo, Carnegie Institute 404, slide 12, row 2, section 2.) $\times 54$.

tion was not complete; in other specimens showing incomplete absorption the line of fusion was marked by isolated portions simulating cysts (fig. 4)—all lying closer to the rectum than to the prostate. In none of the older specimens (fig. 5), where

differentiation is more complete, is there any evidence of the persistence of the fused peritoneal layers as a raphé or cysts.

The rectourethralis muscle appears first as condensations of mesenchyme tissue passing forward from the rectum to the site of the membranous urethra. In a 26 mm. embryo it shows clearly and the symmetrical rectovesical pouch is seen dipping



FIG. 5. SAGITTAL SECTION THROUGH PELVIS OF 67 MM. HUMAN EMBRYO

B, bladder; *U*, urethra; *S*, symphysis; *P*, prostate; *PC*, peritoneal cavity; *V*, vas deferens; *EVS*, external vesical sphincter; *RU*, rectourethralis muscle; *R*, rectum. (Embryo, Carnegie Institute 1656, slide 48.) $\times 18.5$.

down on either side (fig. 6). In later stages it appears, below the peritoneal pouch, as a triangular muscle sharply separated laterally from the levator ani muscle (fig. 7).

GROSS ANATOMY OF PELVIC FASCIA

Because of the confused nomenclature, a brief description of the gross anatomy of the pelvic fascia is necessary.

The visceral pelvic fascia is a membranous diaphragm separating the pelvic cavity above from the perineum below and covering the upper surface of the levator ani muscles. This fascia passing inward from the white line on either side forms the lateral ligaments of the bladder, and at the junction of the bladder and prostate it splits into two layers, one passing up around the

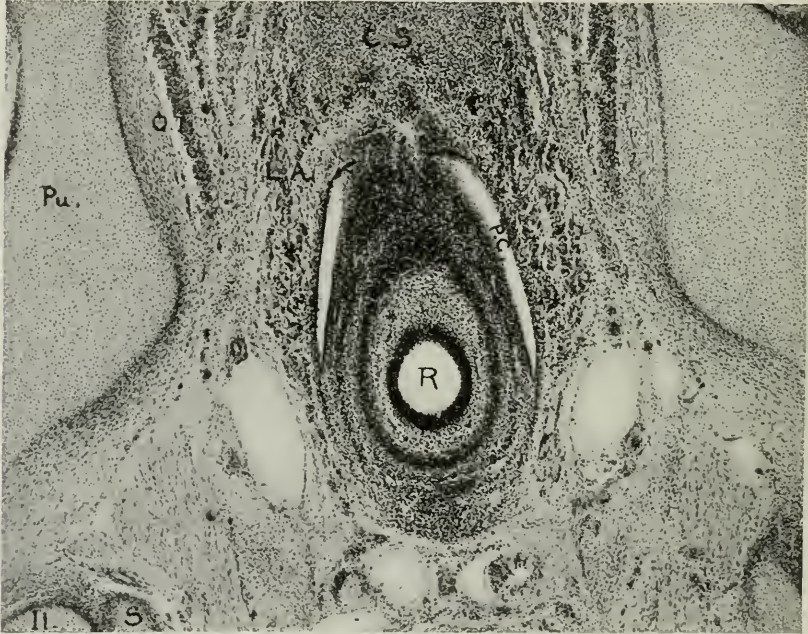


FIG. 6. TRANSVERSE SECTION THROUGH PERINEUM OF 26 MM. EMBRYO

Showing site of future rectourethralis muscle. The peritoneal cavity shows at sides of rectum, but has disappeared in front. *R*, rectum; *CS*, corpus spongiosum; *PC*, peritoneal cavity; *LA*, levator ani muscle; *OI*, obturator internus muscle; *Pu*, pubis; *Il*, ilium; *S*, sacrum. (Embryo, Carnegie Institute 895, slide 63, row 1, section 3.) $\times 54$.

bladder and the other down over the prostate. The former splits into two layers on either side of the midline to enclose each seminal vesicle and vas deferens, and then blending together continue forward over the bladder to the pubis forming the anterior true ligaments. From that portion of the fascia overlying the seminal vesicles and vasa deferentia arises the layer that

forms the outer coat of the ejaculatory ducts and accompanies them through the prostate (fig. 8).

The prostate has a capsule which consists of a comparatively thin layer of fibrous tissue and involuntary muscle fibers closely adherent to the gland and penetrating the substance, being

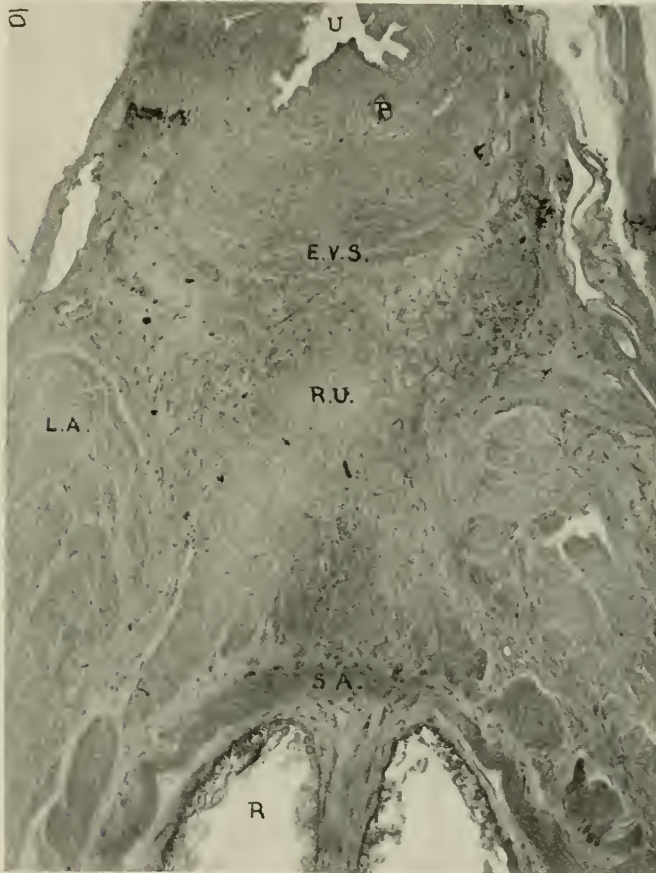


FIG. 7. TRANSVERSE SECTION THROUGH PROXIMAL PORTION OF POSTERIOR URETHRA OF 221 MM. HUMAN EMBRYO

The rectourethralis muscle appears as a triangular sheet, separated from the levator ani by a fascia. *U*, urethra; *P*, prostate tubule; *EVS*, external vesical sphincter; *LA*, levator ani muscle; *RU*, rectourethralis muscle; *R*, rectum; *SA*, sphincter ani, internal, muscle. (Embryo, Carnegie Institute 1172, slide 80.) $\times 21$.

continuous with the glandular stroma it cannot be separated from it without laceration of the gland tissue. It is analogous to the fibrous capsule of the liver or spleen.

Denonvilliers' fascia, or the fascia between the prostate and the rectum, consists of two layers, one covering the prostate



FIG. 8. TRANSVERSE SECTION THROUGH POSTERIOR URETHRA, DISTAL TO VERUMONTANUM, OF 210 MM. HUMAN EMBRYO

A dense fascia surrounds the utricle and ejaculatory ducts separating them from the prostatic tissue. *U*, urethra; *Ut*, utricle; *ED*, ejaculatory duct; *P*, prostate; *PC*, peritoneal cavity; *D*, Denonvilliers fascia. (Embryo, Carnegie Institute 2402, slide 245, section 2.) $\times 18.5$.



FIG. 9. SAGITTAL SECTION THROUGH PELVIS OF ADULTS

Showing diagrammatically the relation existing between the external vesical sphincter (*EVS*) and the rectourethralis muscle (*RU*); if the dissection follows the posterior surface of this muscle the rectum will be opened, but if the muscle is cut at its junction with the external vesical sphincter the rectum will drop back and the prostate be exposed.

and the other the rectum. These two layers meet above at the vesico-prostatic junction, where they both spring from that portion of the visceral fascia which may be said to stretch across the pelvis between the urogenital apparatus and the rectum. When the rectourethralis muscle is divided the incision should likewise divide the posterior or rectal layer of Denonvilliers'



FIG. 10. TRANSVERSE SECTION PROXIMAL TO ORIGIN OF RECTOURETHRALIS MUSCLE OF 130 MM. HUMAN EMBRYO

From the longitudinal layer on the anterior surface of the rectum this bundle of muscle has split off and is shown passing across the rectovesical space; *EVS*, external vesical sphincter; *RU*, rectourethralis muscle; *LA*, levator ani muscle; *R*, rectum. (Embryo, Carnegie Institute 1018, slide 168, row 2, section 3.) $\times 54$.

fascia which is then pushed back with the rectum (fig.9). Thus is formed the "espace decollable retroprostatique" or separable space and the anterior layer of Denonvilliers' fascia or sheath of the prostate is exposed. The texture of this resistant membranous layer resembles the dartos being made up of glistening fibrils most pronounced in the midline.

GROSS ANATOMY OF THE RECTOURETHRALIS MUSCLE

The rectourethralis muscle is of primary importance to the perineal surgeon since it is responsible for the acute anterior

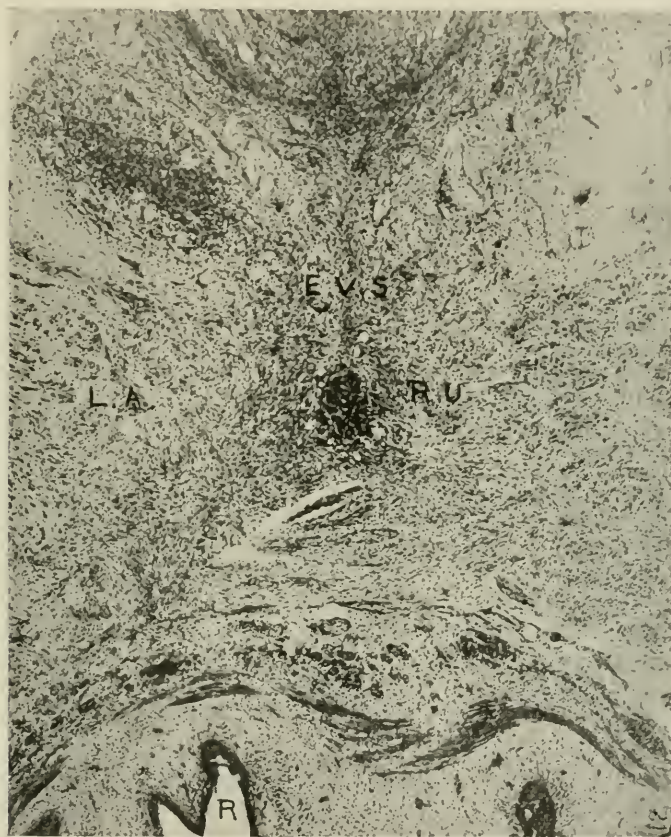


FIG. 11. TRANSVERSE SECTION OF 130 MM. HUMAN EMBRYO

Showing insertion of rectourethralis in raphe of external vesical sphincter. *R*, rectum; *EVS*, external vesical sphincter; *RU*, rectourethralis muscle; levator ani muscle. (Embryo, Carnegie Institute 1018, slide 173, row 2, section 2.) $\times 54$.

flexure of the rectum and its approximation to the apex of the prostate. It is formed by a bundle of muscle fibers which arise from the anterior thickened longitudinal band of the rectum at

the level of the verumontanum (fig. 10) and passing forward fuses with the raphé of the external vesical sphincter (fig. 11). A corresponding bundle passes from the posterior band to the coccyx with the formation of the rectococcygeus muscle.

A study of the specimens of the rectourethralis muscle obtained at operation and prepared with differential stains showed smooth muscle fibers flowing into a bed of elastic tissue containing striated muscle. The striated fibers were part of the external vesical sphincter and the elastic tissue came from the raphé, while the smooth muscle represented the fibers from the rectum.

DISCUSSION

Since fascia are merely condensations of connective tissue, they have marked individual variations in density. From the urological standpoint they are of interest not only as structural supports but as protective partitions which control the course of extravasations of urine and limit the spread of infections and malignant growths. The dense anterior layer of Denonvilliers, fascia is of primary importance in preventing cancer of the rectum spreading anteriorly, and effectively confines early cancer of the prostate, so that it can be entirely eradicated by means of the radical perineal prostatectomy.

The fascia which passes through the prostate enclosing the ejaculatory ducts and utricle, protects them from injury when the adenomata are removed perineally from the prostate gland.

A study of the glass model of the seven-months pelvis shows several points of interest. The deep and superficial transverse muscles are very thin and delicate while the rectourethralis muscle is relatively heavy. It passes forward and downward from the anterior surface of the rectum and blends with the raphé of the external vesical sphincter below the membranous urethra. It shows clearly why if the surgeon fails to sever the muscle at its insertion he will be punished for his carelessness by having to cut through it at the bottom of a deep pocket or else if he dissects far enough he will be led directly into the lumen of the rectum.

Contrary to the generally accepted view, the levator ani muscle lies lateral to the prostate and is definitely separated from it,

and sends no fibers over its posterior surface either directly or indirectly through the rectourethralis.

A study of the testicles, which lie in the inguinal canals is of interest, since one is apparently normal while the other is rotated end for end, so that the globus minor lies above while the globus major is below. Apparently such an embryological



FIG. 12. SAGITTAL SECTION, LATERAL TO MID-LINE OF 67 MM. HUMAN EMBRYO

Showing a Cowper's duct that enters the urethra near the meatus. *B*, bladder; *U*, urethra; *V*, vas deferens; *S.V.*, seminal vesicle; *P*, prostate; *PC*, peritoneal cavity; *R*, rectum; *RU*, rectourethralis muscle; *S*, symphysis pubis; *CC*, corpora cavernosa; *C*, Cowper's gland; *CD*, Cowper's duct approaching urethra. (Embryo, Carnegie Institute 1656, slide 46.) $\times 18.5$.

anomaly can be responsible for torsion of the testicle which manifests itself at a later stage of development.

In another specimen (fig. 12) was seen an abnormal Cowper's duct—which enters the urethra near the coronary sulcus instead of in the bulb. Such an anomaly is undoubtedly the forerunner of a periurethral duct.

SUMMARY

1. Denonvilliers' fascia is not formed by a fusion of the layers of fetal peritoneum.

2. The fetal peritoneum in passing from the bladder to the rectum, dips down between the bladder and the seminal vesicles due to fusion of the genital cords, and then to the perineal floor between the prostate and the rectum.

3. With development these two depressions become less marked; first, by mechanical changes in outline which tend to smooth out all irregularities; and second, approximation of the layers followed by fusion and prompt reversion to undifferentiated embryonic tissue or persistence for a short time of a pseudo-raphé or an occasional cyst where apposition has not been perfect.

4. The rectum, at the level of the prostate, is surrounded by a more or less definite cuff of connective tissue in which the lowest part of the peritoneal cavity dips.

5. At no stage of development is the peritoneum in contact with the prostate, it lying in all cases nearer to the rectum than to the prostate.

6. The recto-prostatic space is filled at first with a synticium or mass of embryonic connective tissue cells; eventually differentiation occurs and there is a condensation of connective tissue anteriorly and posteriorly. The anterior layer, covering the prostate, is the thicker and the elastic tissue fibrils predominate, thereby causing the characteristic shiny appearance of "Denonvilliers' fascia."

7. A sheath of fascia surrounds the ejaculatory ducts and utricle as they pass through the prostate.

8. The rectourethralis is a sheet of muscle arising from the external longitudinal layer of the rectum and ending in the raphé of the external vesical sphincter.

9. In exposing the prostate by the perineal route the rectourethralis muscle should be cut close to the central tendon, the incision being sufficiently deep to sever the posterior or rectal layer of Denonvilliers' fascia, and the dissection continued anteriorly to the muscle, for if the posterior layer is followed it

leads directly into the rectum. If the incision is made anterior to the central tendon the dissection leads first into the venous bulb, and then through the external vesical sphincter. The opening of the rectum is avoided, but there is a prolonged and often permanent loss of vesical sphincter control.

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THE OPERATIVE CURE OF INCONTINENCE OF URINE WITH ILLUSTRATIVE CASES¹

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I wish to bring before you today some cases in which a prominent symptom was urinary incontinence and to discuss the varied problems which they have presented and the operative technique which we have found satisfactory.

GROUP I. POST-OPERATIVE INCONTINENCE

This group includes cases in which the incontinence has come first, as a result of median urethrotomy and prostatectomy, and second, cases of perineal prostatectomy. In these cases there is usually a wide dilatation of both the internal and external sphincters, and the urine flows away from a lack of function of both sphincters. The conditions present are shown in figure 1, in which one sees the membranous urethra widely dilated, owing to the division of the external sphincter posteriorly; post-operative scar tissue in the perineum; and a widely dilated internal sphincter, with absence of the usual elevation of the median portion and with scar tissue replacing the muscle in that region. As seen here the surgical problem is to excise the scar tissue and redundant mucous membrane, and find suitable muscle with which to reproduce a functioning sphincter both at the vesical orifice and in the region of the triangular ligament—external sphincter. The operation which I have now carried out in various cases is generally as follows:

¹ Read before the American Association of Genito-Urinary Surgeons, Washington, March, 1922.

1. *Suprapubic cystotomy—Plastic operation upon the internal sphincter*

A fairly long median incision is made and the bladder is opened widely so as to get a good exposure of its base. In these cases an examination of the prostatic orifice will usually show a wide-open urethra, and in cases in which the old operation of median prostatotomy has been done, the trigone is sometimes found completely divided, so that one finds a furrow between the divided edges of the trigone and an absence of the usual elevation in the median portion of the prostate. After prostatectomy, the trigone is usually found intact, but the same injury to the sphincter posteriorly is found and the wide-open internal orifice is present. Examination will usually reveal an absence of the usual muscle in the posterior lip or median portion of the prostate and the finger can be introduced deeply into the posterior urethra. The problem is manifestly to excise the mucous membrane, find the muscle and draw it together posteriorly. This is shown very graphically in the accompanying drawings. Figure 2 which was taken from one of our cases shows the internal orifice to be a wide, vertical opening with absence of the usual musculature posteriorly and the anterior part of the trigone. Insert A in the corner shows the free dissection of mucous membrane which was carried out, exposing the muscle of the anterior part of the trigone and also of the two sides of the prostatic orifice. The excision of mucous membrane was carried for a distance down into the urethra so as to leave a considerable mass of muscle on each side of the vesical neck to be brought together with sutures. For this purpose we now use our "boomerang" needle holder (fig. 3) which is well suited for deep suturing. Figures 4 and 5 demonstrate the use of this instrument, and figure 6 shows the condition after placing four stitches so as to draw the muscle and mucous membrane together, leaving only a small and fairly tightly closed urethral orifice above. The suprapubic wound is closed, leaving only a small opening through which the drainage tube emerges, the bladder being approximated with a continuous chromicized catgut and the skin and recti muscle with interrupted stitches of silver wire.

2. *Excision of perineal scar tissue and plastic to restore the external sphincter*

Figure 7 shows a case in which there was a fairly wide area of post-operative perineal scar. In this case an elliptical incision was made and carried rapidly through the skin and subcutaneous tissues so as to dissect out the scar tissue, as shown in figure 8. In doing this, the muscle on each side was exposed. The excision was carried out until the urethra (in which a no. 18 sound had been previously passed) was reached. Examination then showed that the mucous membrane was redundant, and accordingly an area was excised on each side (fig. 9), reducing the calibre greatly. Additional fibrous tissue was excised on each side until fairly healthy muscle was reached. The closure was effected with the "boomerang" needle holder, as shown in figure 10, the urethral mucous membrane being first brought together so as to invert the edges slightly with a continuous chromicized catgut. The muscle structures on each side were then brought together by a row of deep sutures of catgut, as shown in insert *A*, and the subcutaneous tissues were approximated by a third row of chromicized catgut, as shown in insert *B*. The wound was then packed loosely with gauze and the skin edges were not approximated, as I have found in plastic work upon the perineum, that if the deep structures are brought together in two or three layers, it is unnecessary to bring the skin surfaces together, and if they are thus left open for drainage, there is far less danger of wound infections, stitch abscesses, etc. If the deep wound heals per primam no trouble will be experienced in the closure of the skin. The small sound which is in the urethra is removed before the final closure in the perineum, and no catheter or foreign body is left in the urethra, drainage being entirely supplied by the suprapubic tube which is kept in place for about three weeks when it is removed and the suprapubic wound allowed to heal. I have usually found it advisable to pass a filiform and follower about this time as it was necessary to dilate the urethra in the sutured portions, particularly at the internal orifice which I have usually found over-corrected by the operation and tighter than normal.

Case 1. J. J. M. Age thirty-eight. No. 1502, Brady Urological Institute. Admitted January 30, 1907, with complete incontinence of urine night and day, following perineal urethrotomy, which had been performed one year previously on account of frequent urination and severe pain in the bladder. The operation had not relieved the pain and had produced incontinence. The prostate was not hypertrophied, a slight stricture was present at the bulbomembranous region, but filiforms and followers were easily passed. The bladder held 325 cc.; no residual urine. The tubular urethroscope showed a dilated posterior urethra; verumontanum red and swollen. In the region of the external sphincter there was a long wide slit posteriorly, and there was no central point of closure, but the sides of the urethra were approximated loosely on each side, showing that the sphincter had been divided posteriorly.

Operation was carried out on January 6, 1907, according to the technique previously described.² The vesical orifice was found to be gaping, so that the index finger could be easily introduced, and it was evident that the sphincter had been divided posteriorly, and the mucous membrane had healed over the cut. Examination showed what seemed to be the end of the sphincter on each side. These were caught up with tenaculum forceps, the mucous membrane excised posteriorly and laterally, and two catgut sutures placed so as to draw the muscles well together and reproduce a well-closed sphincter. In so doing a small artificial median bar was produced. A large mass of scar tissue was found in the perineum, extending from the cutaneous scar, which was quite broad, to the urethra itself, and from the posterior part of the bulb along the membranous urethra to the anterior portion of the prostatic urethra. Since the median incision through this scar tissue showed no evidence of muscle adjacent to the urethra, a considerable mass was therefore excised on each side, together with some urethral mucous membrane which was very redundant and thick. At no place did the urethra come together as if there were sphincter surrounding it. This dissection was carried well out on each side until healthy looking muscle was reached, it being necessary to go for a distance of about one centimeter. On the left side a definite sphincter-like mass was found. On the right it was not so definite, the fibers appearing longitudinal rather than circular. Healthy looking muscle was also obtained on each side well down toward the prostatic apex. The mucous membrane was drawn together with three sutures of catgut at wide intervals, muscular

² H. H. Young, an operation for the cure of incontinence of urine. *Surgery Gym. and obstetrics*, January, 1919, pp. 84-90.

tissues were then brought together with the necessary sutures of catgut, care being taken, in the region of the membranous urethra, to obtain good muscle for approximation.

Convalescence. The patient, who was addicted to morphia, required 19 to 25 grains daily for almost a week. On the eighteenth day the patient voided a small amount of urine through the urethra. February 9, 1907. Suprapubic tube removed. Patient voiding urine through the urethra without pain, no incontinence, stream small. February 14, 1907: Suprapubic wound closed. Patient voiding through the urethra without pain. February 25, 1907. Evidence of urethral stricture present. Filiform and followers passed, after which patient voided much more freely. May 17, 1907. After dilatation on March 29, patient had slight incontinence for four days. He is now able to retain urine for six hours, voids freely, no pain, good stream, has taken no morphia for four weeks. Is discharged in good condition.

June 25, 1907. Filiform and followers passed on account of slight stricture. Patient retains urine all night without voiding. There is no incontinence. Has taken no morphine.

November 21, 1907. A letter states that the result is almost perfect. He voids urine only once at night, the stream is a little slow in starting, but urination is usually free. He is cured of the drug habit. November 25, 1916. "I have had no sounds passed during the past nine years. I can hold urine four hours, stream good, void urine more frequently at night, am in business and enjoy good health."

Case 2. C. C. Age twenty-five. No. 2708, Brady Urological Institute, was first admitted October 25, 1910, complaining of pain in the perineum. He had gonorrhea about eight years previously, and for one year had had symptoms of prostatic irritation and diminution in sexual power. Examination showed prostatitis and verumontanitis, for which he received local treatment.

Contrary to my advice he had a prostatectomy performed elsewhere, and returned to me, a few months later, complaining of greatly increased burning, and incontinence of urine. He said that an attempt had been made in Chicago to remove the prostate through the perineum, and that he had been very much worse. There was almost continuous incontinence. The cystoscope showed that both the internal and external sphincters had been divided and had failed to close. Local treatment was given but failed to relieve the burning, and urethral dilatation and muscle exercises for the sphincters did not help the incontinence.

The patient then left me again and returned to another surgeon, who operated again through the perineum, and when he came back he not only had incontinence and burning, but also a recto-urethral fistula.

April 9, 1914. Cystoscopic examination showed the internal sphincter had been divided posteriorly. The verumontanum was not seen. The connection with the rectum could not be made out. The internal sphincter was apparently wide open. The external sphincter also failed to close and when the patient was instructed to attempt to close his sphincters, neither internal or external sphincter became completely closed. Rectal examination showed a fistulous opening about 2 cm. within the anal margin.

April 4, 1916, urethroscopy. No. 28-F. urethroscope passed with ease into the bladder. Just in front of the vesical orifice the lateral lobes were a little more rounded than normal. The median portion was depressed, and it was evident that the internal sphincter had been injured posteriorly. The floor of the urethra was irregular, and as the urethroscope was drawn outward, urine continually escaped from the bladder. The utricle and ejaculatory ducts could not be found. The external sphincter was dilated, forming a vertical slit instead of a central figure.

April 4, 1916, cystoscopy. With the posterior cysto-urethroscope the internal sphincter was seen to be dilated. The lateral lobes were a little more rounded than normal, and the median portion much depressed; evidently considerable tissue absent in this region. When the instrument was withdrawn into the posterior urethra, the latter was found to be very irregular, with depressions along the floor, and the verumontanum could not be seen. There was a great deal of scar tissue present. A depression was seen in the anterior part of the posterior urethra, and another small opening just behind the external sphincter, which probably connected with the rectum.

Patient still complained of constant incontinence, escape of urine into the rectum and gas through the urethra, and a severe burning pain.

April 5, 1916. *Operation. Young.* (1) *Suprapubic cystostomy. Plastic operation to repair dilated internal sphincter.* (2) *Perineal excision of scar tissue. Excision of cuff of rectum with rectal fistula. Closure of opening into posterior urethra. Excision of scar tissue posterior to external sphincter. Plastic operation to repair external sphincter.*

Suprapubic operation. The prostatic orifice was found to be widely dilated with loss of tissue posteriorly, and the scar extended backward in the shape of a shallow trough to the posterior limit of the trigone, which had evidently been completely divided.

The muscles of the trigone and median portion of the prostate were evidently widely separated, and the index finger could be inserted with ease into the posterior urethra. The repair sutures produced a distinct median bar which elevated the prostatic orifice considerably and left a very small opening into the posterior urethra. Suprapubic drainage was provided as usual.

Perineal operation. A racquet-shaped incision was used, the posterior portion encircling the anus as in the operation for recto-urethral fistula, which has recently been reported by Dr. Harvey Stone and myself.³ The scar tissue in the perineum was excised until the urethra was reached, leaving a fairly large opening in the midline which extended back, and included the connection between the rectum and urethra. The sphincter ani was not divided, but was pushed backward while operating upon the urethra, and drawn forward while operating upon the rectum. The rectal cuff was freed on all sides from within the sphincter, which was well preserved, and the fistulous tract having been divided, the cuff was drawn downward until the fistula had been drawn beyond the skin level, where the cuff bearing the fistula was excised. Previous to this the urethra had been closed with five interrupted stitches of fine chromic catgut, and the external sphincter muscles had been drawn together with several stitches of chromic catgut, the anterior mucous membrane was then sutured to the skin as in the Whitehead operation and the perineal wound was partly closed, leaving a small area for drainage.

Convalescence. The patient made an uneventful recovery and was discharged from the hospital in thirty-seven days. He was then able to retain urine for three or four hours, voided freely, and had absolutely no incontinence. No sounds, filiforms or followers were passed on the patient at any time after the operation.

About two weeks later the patient returned and examination showed continued improvement. He was able to retain urine five hours, had no incontinence, voided freely and without difficulty.

May 17, 1917. Patient returns for examination. He reports that he is able to retain urine six hours. Sometimes does not get up at all at night to urinate, occasionally once or twice, voids freely, good stream, no pain. Has had no incontinence since operation, and no evidence of rectal fistula. Still has slight burning pain in the prostatic region, and the urine is cloudy with some pus present. General health is excellent.

October, 1918. Excellent result maintained.

³ H. H. Young and Harvey B. Stone, The operative treatment of urethro-rectal fistula, presentation of a method of radical cure. Jour. of Urol., June, 1917, i, no. 3.

Case 3. J. W. S. Age fifty-two. No. 10,000, Brady Urological Institute. Admitted October 4, 1921, complaining of incontinence of urine. There was a history of gonorrhea at the age of twenty-seven, followed subsequently by chronic prostatitis and changes in sexual powers, and for twelve years there were symptoms of burning, hesitation and frequency of urination. Two years previously had had a suprapubic operation at which time the internal sphincter and neck of the bladder were widely dilated. As this did not relieve the symptoms, patient had a second operation several months later when an external urethrotomy was performed through the perineum. Following this patient had incontinence of urine and continued to have pain in the urethra and bladder with occasional hematuria.

Examination showed perineal and suprapubic scars. Prostate was only slightly larger than normal and slightly indurated. Seminal vesicles were indurated and adherent. Cystoscopy showed a wide cleft posteriorly between the lateral lobes. Upon drawing the cystoscope out, a deep scar in the floor of the urethra could be seen. Examination of the perineum showed a depressed scar, and it was thought advisable to carry out the radical operation on both internal and external sphincters.

October 10, 1921; *suprapubic cystostomy*. The prostatic orifice was found to be wide open and in the median portion there was a deep furrow which included the anterior part of the trigone and extended down into the posterior urethra. There was considerable scar tissue present. This was excised with the mucous membrane and the muscle tissues were brought together as usual with three chromic catgut sutures which were inserted with the "boomerang" needle holder. The *perineal operation* was carried out as usual. A considerable amount of scar tissue was excised and redundant mucous membrane along the floor of the urethra was removed. Considerable destruction of the muscular structures of the perineum had occurred but it was possible to get fairly good muscle which was drawn together with the "boomerang" needle holder.

Convalescence. The suprapubic tube provided satisfactory drainage for the bladder which was removed during the third week. One month after the operation a small catheter was passed through the urethra and fastened there to facilitate closure of the suprapubic wound. It was removed five days later, when the suprapubic fistula was closed and the patient was voiding normally through the urethra.

November 30, 1921. All wounds closed; patient has perfect urinary control and voids at intervals of four to six hours without pain or discomfort. Urine is still infected. December 3, 1921: Patient dis-

charged voiding at intervals of every six hours with excellent control. Urine still infected.

GROUP II. VESICAL PERINEAL FISTULA WITH INCONTINENCE
FOLLOWING FRACTURE OF THE PELVIS

This condition has been met with at the Brady Clinic in three cases, one from the practice of Dr. Colston to whom I am indebted for the privilege of including it. In these cases, following severe accident, the pelvis was badly fractured and the bladder and urethra ruptured with resultant incontinence of urine which was found in all cases to be due to the formation of peri-prostatic vesico-perineal fistulae. In these cases the operation required both suprapubic and perineal attack with excision of the fistulous tract, closure of its internal orifice, closure of the perineal wound, and, in one case, repair of the external sphincter. The procedures carried out have varied in each of these three cases are briefly given and illustrated by the accompanying drawings.

Case 4. W. H. M. Age twenty-two. No. 8592, Brady Urological Institute. Admitted March 18, 1920, complaining of leakage of urine through penis and old perineal fistula. Present illness dates back to 1914 when his right pelvis was crushed in an accident. He was in the hospital for six months during which time he was operated upon four times. The perineal fistula never closed, and in 1918 he was again operated upon, an effort being made to close the fistula, but with no result. Following this operation, he developed incontinence and was unable to hold urine. At present he passes urine through the urthra but has complete incontinence. There is also a slight leakage of urine through perineal fistula. At night there is generally no leakage and patient is able to retain urine for five or six hours while on his back. As soon as he stands or walks, urine begins to escape. His sexual powers have become diminished since accident and erections are very incomplete. General health is excellent. No history of pain.

Examination. General physical examination is negative. Penis is normal in size. There is urine dripping for the meatus. Testes and epididymides are normal.

Rectal. On examination of the perineum, a deep fistulous opening is found in front and to the left of the anal opening. The anal sphincter is of good tone but the anterior wall of the rectum is bound up in scar

tissue which also involves the perineum. The prostate is a little more prominent than normal but smooth. Right lobe is normal in consistence nodular and adherent. Left lobe is slightly indurated, drawn outward considerably and adherent. Both seminal vesicles are enlarged, indurated and adherent externally and to the prostate below. Between the vesicles the tissues are indurated, forming an intervesicular plateau which extends 1 cm. above the base of the prostate.

Urine. Acid, cloudy, specific gravity 1.012, trace of albumen, no sugar, no casts, moderate amount of pus. Infection: colon bacillus.

Phthalein test. Intramuscular; Appearance time, 12 minutes; two hours, 70 per cent.

Instrumentation. Sounds up to no. 26-F. are quite readily passed into the bladder, taking a course slightly to the right of the midline when the posterior portion of the bulbous urethra is reached. There is no residual urine present; bladder capacity 230 cc. Urine is quite cloudy. When considerable fluid is introduced into the bladder, none escapes through the perineal fistula.

March 27, 1920, cystoscopy. Cysto-urethroscope passes with ease. There is no residual urine and bladder capacity seems about normal. Cystoscopy shows a fairly normal trigone and normal ureteral orifices. Just in front of and to the right of the trigone and midway between the ureter and the prostatic orifice there is a deep depression which seems to be the intravesical orifice of a fistula. The prostatic orifice is apparently dilated, the posterior margin is less pronounced than usual, and it is possible to draw the cystoscope out of the bladder into the posterior urethra without passing the intervening median elevation which is usually seen. The entire prostatic margin is less sharply defined than normal. The verumontanum is not definitely made out, and to the right of the median line posteriorly there is a peculiar deep depression or hole. A filiform passes from the perineum into the urethra at this point, thus demonstrating the presence of a urethral perineal fistula. In order to study the external sphincter, a tubular urethroscope is introduced, no. 28-F. It is impossible to introduce the instrument into the prostatic urethra owing to the cicatricial ring which is quite visible. The floor shows a linear cleft or depression such as are seen after median perineal urethrotomies in which the external sphincter has been divided. This condition extends well out into the bulbous urethra. The lateral and superior walls of the urethra are quite normal.

Impression. We have here incontinence of urine due to injury and dilatation of both the internal and external sphincters, also a fistula

from the perineum to the prostatic urethra and probably a fistula from the base of the bladder connecting with the other fistula.

Indications. Suprapubic cystostomy; closure of vesical fistulae; repair of internal dilated sphincter; suprapubic drainage; perineal operation to excise the perineal fistulae and repair internal sphincter.

March 29, 1920. *Operation, Young. Gas and ether. Suprapubic cystostomy with excision of two fistulous tracts. Perineal section with excision of fistulous tract connecting with the mid portion of the prostatic urethra and bladder. Excision of perineal scar tissue and repair of external sphincter and triangular ligament. Suprapubic drainage.* The bladder was opened by linear suprapubic incision and an excellent view obtained. Inspection showed two fistulous openings (the ones which had been seen with the cystoscope), about 1 cm. in diameter and to the right of the trigone, about midway between the ureters and prostatic orifice. This easily admitted a large clamp which passed for a considerable distance and communicated with the fistulous tract in the perineum. In front of this and to the right of the prostatic orifice a second fistulous opening was found (which had not been seen with the cystoscope) about 5 mm. in diameter, which readily admitted the probe for a distance of 2.5 cm., apparently pursuing a course anterior to the prostate, whereas the posterior fistula took a course that was retro-prostatic. The operator decided to excise these fistulous tracts and placed the patient in the perineal prostatectomy position upon the Young urological table. A midline incision was then made in the perineum, the posterior end of which encircled the fistula which lay near the anus. The incision was carried through the scar tissue to the urethra and the fistulous tract excised to a point where it communicated with the prostatic urethra. Here it was found that the fistulous tract divided, one passing anteriorly to the right and opening into the bladder to the right of the prostatic orifice. The other travelled posteriorly behind the prostate and opened into the bladder to the right of the trigone. The latter tract was dissected free up to near the bladder, a small prostatic tractor which had been inserted through the fistula into the bladder being of considerable assistance in drawing down the fistulous tract towards the perineum. The tractor was then removed. The operator then turned his attention to the suprapubic wound and passed a clamp through the posterior fistula until it appeared beyond the fistulous tract. Here an assistant inserted into the separated blades of the clamp the lower extremity of the freed fistulous tract, and traction was then made from above inverting the fistulous tract and

drawing it into the bladder where it was excised completely. The tract which travelled anteriorly and opened into the bladder to the right of the prostatic orifice was thoroughly curetted up to the vesical orifice. By means of the Boomerang needle holder four interrupted catgut sutures were placed extravasically through the perineum so as to close completely the posterior fistula. The anterior fistula was closed intravesically after thorough excision of the edges with scissors and curettage, four sutures of chromicized catgut being used. Attention was then directed towards the triangular ligament and external sphincter which was surrounded by an extensive mass of scar tissue. This had to be excised before normal tissue was found on each side. A portion of the mucous membrane was excised so as to reduce the dilated urethra, and after apparently healthy muscle had been secured on each side, the urethra was drawn together with a layer of four interrupted sutures of no. 2 chromic gut and a second layer of sutures approximated the muscular structures around the urethra. The skin was not drawn together but packed superficially. The bladder was then cleaned of clots and an inspection of the vesical orifice showed the sphincter was of good tone. It was therefore decided to do nothing to it, as the incontinence was thought to be explained by the leakage through the fistulous tracts rather than relaxation of the sphincter. The suprapubic wound was closed with a drain at the upper end, and the skin and recti muscle were drawn together with interrupted sutures.

The operation was long and tedious and the patient was slightly shocked at the end; pulse 110.

Convalescence. On returning to the ward, patient was considerably shocked and an infusion of salt solution was given. After this, patient made a satisfactory convalescence. On the fifth day the suprapubic tube was removed and a Pezzer catheter inserted suprapubically. On the eleventh day suprapubic tube was removed and not replaced. On the fifteenth day urine passed through the penile urethra and on the eighteenth day patient was out of bed. There was no perineal leakage. On the twenty-seventh day patient had good urinary control and there was a very slight suprapubic leakage. Two weeks later the suprapubic fistula healed completely.

June 9, 1920. Patient discharged with suprapubic and perineal wounds completely healed, no fistulae. Patient is able to retain urine for three hours; has a slight leakage on moving around. On voiding, he can stop the outflow of urine voluntarily and start it at will. He is advised to practise his sphincter muscles in order to improve their tone.

June 14, 1922. *Letter.* "Soon after leaving the hospital, I began to lose control of urination (would dribble) while on my feet, while at night I have been able to retain my urine for five or six hours without incontinence. If I am sitting in a comfortable position, I can go sometimes for two hours and can retain urine for twenty minutes after I begin moving around. Then the muscles seem to relax and I lose control. I void urine freely and can stop it while I am lying down. Sometimes I can stop the flow when I am standing but not always. I have had two nocturnal emissions but erections are very imperfect and intercourse has proved impossible. Sexual desire is slightly impaired."

Remark. This patient should be cystoscoped to find out whether one or both of the internal vesical orifices of the fistulae have reopened. The perineal fistula is well closed and the patient seems to have fairly good control of the external sphincter. At cystoscopy it was thought the internal sphincter was dilated but at operation it was thought to be normal and no attempt was made to tighten the prostatic orifice. The question therefore arises, is the failure to get a perfect result in this case due to a dilated internal sphincter or a reopening of the vesical end of one of the two fistulae, the perineal orifice of which has been successfully closed? Patient advised to return for examination.

Case 5. C. J. D. Age forty-two. No. 9234, Brady Urological Institute. Admitted November 18, 1920, complaining of incontinence on urine and pain, suprapubic and perineal fistulae. Three years before the patient was struck by an automobile truck and sustained a fracture of the pelvis with rupture of the urethra and extravasation of urine. He was taken to Boston and operated upon by a surgeon there who found "the ramus of the left side fractured and pushed into the bladder. This fragment was removed by a suprapubic incision, when a rupture of the bladder and of the urethra were discovered. The urethra was torn off at the junction between the membranous urethra and prostate, and the whole anterior surface of the prostate was split open." Patient was badly shocked and it was possible only to pack the suprapubic and perineal wounds. The suprapubic wound healed in about a month, but a perineal fistula remained and the patient had incontinence of urine until about a year later when he had acute retention of urine, and as it was impossible to insert a catheter through the urethra, the surgeon carried out another suprapubic operation for drainage. At the second operation, several small stones and some necrotic bone were removed through the perineum, and a plastic operation was carried out to reestablish the urethra which had been ruptured at the apex of the prostate.

During the ensuing months, patient had repeated perineal abscesses and the suprapubic and perineal sinuses both closed and opened spontaneously several times. Incontinence of urine was present; bladder capacity small. A third operation was carried out several months later, which showed "a deformed pelvis encroaching upon the urethra and bare bone along the left lateral wall of the urethra to which it was closely adherent." Following this operation, patient continued to have incontinence of urine and the perineal fistula did not heal. This was the condition present on entrance. Since accident patient has had no erections.

Examination showed in the midline above the pubis a depressed scar but no fistula. In the perineum there was an extensive scar with a fistula through which urine escaped. With finger in rectum and thumb against perineum, a hard movable body, probably a stone, about 1.5 cm. in length could be felt in the urethra. On rectal examination, prostate was a little broader than normal, slightly irregular, indurated in its upper portion, the induration extending up into the region of the bladder, giving one the impression of a calculus which projects from the bladder into the prostate. X-ray examination showed a shadow about $1\frac{1}{2}$ inches in diameter in the region of the bladder, and also a smaller shadow in the median line beneath the symphysis pubis, probably in the membranous urethra. Conditions present, as subsequently discovered, are shown in figure 11.

November 23, 1920. *Operation, gas and ether anesthesia. Perineal and suprapubic operations to remove calculi from perineum, urethra and bladder. Partial excision and curetment of sinus running from the anterior wall of the bladder into the perineal urethra.* Patient was first placed in the perineal prostatectomy position and an incision about an inch long was made, enlarging the fistula and exposing a stone in the perineal urethra. This stone proved to be about one inch in length and $\frac{3}{4}$ inch in diameter and was easily removed. It lay in the region of the membranous urethra but projected into the apex of the prostate. The external sphincter was apparently destroyed or widely dilated, and the membranous urethra was very large and surrounded by much cicatricial tissue. Just in front of the stone there was a fistula which extended behind the symphysis pubis and into the bladder, more or less paralleling the prostatic urethra, and it seems probable that urine escaped through this fistula and that the urethra was blocked by the calculi. The finger could be introduced through the prostatic urethra into the bladder where a large calculus was detected. Patient was then placed in the Trendelenburg position and suprapubic cystostomy performed. The bladder was con-

tracted, the anterior wall very thick, and a stone about 2 inches in diameter was removed without difficulty. There was no diverticulum present. The prostatic orifice was slightly dilated but there was "no fibrosis or suggestion of contracture." The internal sphincter seemed to be intact though possibly slightly dilated. On the anterior wall of the bladder, at a point about 1.5 cm. distant from the prostatic orifice, and anterior and external to it on the left side, was an irregular orifice of the fistula (figure 12) which communicated with the urethra in the bulbo-membranous urethra as above described. This fistula was exposed by continuing the anterior vesical incision downward; and it was thoroughly cureted and granulations and scar tissue partially excised and packed iodoform gauze. Suprapubic abdominal muscles closed with silver wire.

Convalescence. The perineal and suprapubic fistulae persisted and patient had incontinence. It was found impossible to pass instruments into the bladder owing to obstruction near the apex of the prostate. It was finally necessary to insert a cystoscope through the suprapubic wound and thus to pass a ureteral catheter from the bladder through the prostatic urethra and out the perineum, thus dilating the stricture at the apex of the prostate, after which instruments were passed through the perineum into the bladder, and subsequently also filiforms and followers were passed through the urethra.

April 26, 1921. Patient has almost complete incontinence night and day; is unable to retain urine for more than fifteen minutes. Urine escapes through perineal fistula and only slightly through the penis. Suprapubic wound healed. Sound passes through the urethra into the bladder easily and shows no evidence of stricture.

On May 12, 1921, as the incontinence of urine persisted, I decided to carry out a *radical operation* for its cure. This was done under gas, ether and oxygen anesthesia. Suprapubic cystostomy was first done. Prostatic orifice was found to be slightly dilated, with a tear in the left lateral margin and the musculature in this region less abundant than normal. The trigone was shortened and thickened. About two centimeters distant from the prostatic orifice, on the anterior wall, there was a fistulous opening through which a probe could be passed beneath the symphysis pubis and out through the perineal fistula. It was decided to close the vesical orifice of this fistula, and the edges were therefore thoroughly excised, the bladder wall separated from the symphysis to which it was very adherent, the tract and sinus thoroughly curetted and the vesical orifice of the fistula closed with a continuous through and through chromocized catgut suture (figure 13). The prostatic orifice was then

tightened by excising the mucous membrane posteriorly and drawing the muscle together from each side as usual, two interrupted sutures being used. After closing the bladder and supplying suprapubic tube drainage, the patient was placed in the perineal position and the scar tissue surrounding the perineal sinus was excised. The urethra was found to be widely dilated and redundant, and the fistula which connected with the anterior wall of the bladder was discovered and thoroughly curetted and the tissues around it partly excised. The muscle structures in the region of the triangular ligament were evidently badly injured and no evidence of the external sphincter could be made out. The redundant urethral mucosa was then excised and muscle tissue drawn together so as to restore, as much as possible, the external sphincter. Although there was much more scar tissue and destruction of normal tissues than usual, a fairly good approximation was obtained, three layers of chromicized catgut sutures being placed and the skin left open and packed loosely with iodoform gauze. The suprapubic tube was removed at the end of a month, after which patient began to void through the urethra and micturition slowly but steadily improved. Patient was discharged July 16, 1921 with both perineal and suprapubic wounds well healed, able to retain urine two to three hours with good control, voiding naturally and a good stream. Has occasional leakage and has slight incontinence at night. Condition steadily improving.

September 1921. Patient reports for examination. All wounds are healed. Micturition is quite normal, patient voiding naturally and with no incontinence. General condition excellent.

Case 6. J. F. Age thirty-four. No. 10365, Brady Urological Institute. Was admitted March 17, 1922 complaining of incontinence following injury. No history of venereal diseases. On November 6, 1919 patient fell from a telegraph pole, fracturing the pelvis and rupturing the bladder. At operation a perineal drainage tube was inserted and fracture of the pelvis treated by fixation with sand-bags. After ten days the tube was removed but the fistula persisted and patient had complete incontinence. In May, 1921, he was operated upon elsewhere, the fistula excised, the stricture dilated and drained again through the perineum. Tube was removed within ten days and retention catheter inserted through the penis. The fistula closed only for about two weeks; since then it has been open, and for a time there was frequent urination during the night and incontinence during the day. Urination gradually became more difficult, and for six months patient had frequent

attacks of complete retention of urine, requiring catheterization. At other times he voided with difficulty and marked frequency. When the bladder became full there was incontinence and patient was unable to control his bladder, although voiding with marked frequency.

On examination, patient was wearing a retention catheter. In the perineum there was a broad scar in the center of which there was a fistula. Prostate was about normal in size but adherent. The vesicles were slightly thickened and adherent. Base of the bladder was negative. Catheter was introduced and cystogram taken. Bladder capacity 600 cc.

Cystoscopy. Cystoscope enters with considerable difficulty apparently meeting an obstruction near the vesical orifice. Study of the internal orifice shows no anterior cleft, lateral lobes not hypertrophied intravesically. On looking posteriorly towards the right one sees a cleft which is apparently a tear through the internal sphincter. The cystoscope can be withdrawn into the urethra where much scar tissue can be made out. The bladder mucosa is everywhere markedly congested, and the trigone can not definitely be seen. There is no trabeculation, no tumor, stone, ulcer, etc.

Operation. March 22, 1922. Colston. *Suprapubic Cystostomy excision of fistulous tract on anterior wall of the bladder; closure of bladder with chromicized catgut; suprapubic drainage.* When the bladder was opened, the condition present is graphically shown in figure 14. As is seen here, there were two openings on the anterior wall of the bladder which were found to be separated by small septum of fibromuscular tissue which was completely excised, thus producing one orifice in the bladder. Investigation then showed that the fistulous tract opened into the urethra in front of the prostate, probably through the anterior part of the membranous urethra. The prostatic orifice was apparently normal but there was a stricture at the apex of the prostate, and a sound introduced through the meatus passed through the fistulous tract into the bladder. It was through this that the cystoscope had been introduced. The fistulous tract was excised as completely as possible and then thoroughly curetted and closed by two layers of interrupted catgut stitches which were placed with the Boomerang needle holder, as shown in figure 15, *A* and *B*. The obliterating stricture at the juncture of prostatic and membranous urethra was removed and large sounds were passed freely through this region into the bladder, apparently completely relieving the obstruction. The rest of the bladder was normal and nothing was done to the prostatic orifice. It was evident the incontinence was caused by the urine flowing out through the fistula.

A catheter passed through the urethra and into the bladder through the prostatic orifice, was left in place. Suprapubic drainage was also provided, the bladder wound being closed up to the point of drainage at the vertex. The recti muscles and skin were closed with interrupted stitches of silver wire.

The patient was then placed in the perineal position and the perineal fistula excised and closed with catgut.

Convalescence. Slow but fairly satisfactory. The catheter was removed after a week but later had to be reinserted after dilatation of the urethra with filiforms and followers. Within a month fairly normal urination with good control through the penis was obtained, but the suprapubic fistula reopened intermittently.

June 16, 1922. On discharge, the suprapubic wound had been healed for a week and the epididymitis from which he suffered was much improved. The patient was then voiding at intervals of four hours without hesitation or pain. The urine was cloudy and contained pus and cocci in abundance.

Remark. This case differs from the others in that, in addition to incontinence, the patient had intermittently complete retention of urine and required catheterization. This was due to complete closure of the prostatic urethra at the apex and recurrent contracture of the fistula through which the urine escaped, thus requiring dilatation with catheters. The patient was cured by excision of the fistula and removal of the stricture of the prostatic urethra.

GROUP III. INCONTINENCE FROM PERINEAL VESICAL FISTULA ASSOCIATED WITH DERMOID CYST OF PREVESICAL SPACE

One case of incontinence belongs in this group. I have never met with a similar case in the literature but cannot claim that the study has been exhaustive. Details of the case are as follows:

Case 7. J. C. Age thirty-six. F. 80522, Dispensary. Patient first came to the hospital at the age of thirty-six, complaining of frequency of urination, pain and a fistula in the right side of the perineum through which urine escaped. His history was briefly that at the age of nine years he had a fall on the street, following which he had an abscess in the right groin by the side of the scrotum. This abscess discharged pus and formed a fistula through which pus escaped but no urine. He also had abscesses elsewhere and a suppurative sinus on the outer side of the leg on the left side, in which subsequently dead bone was discovered, and

which during the future years would heal up and then open again and discharge pus; occasionally it would remain healed for two to three years. There was no urinary disturbance at this time. Ten years later at the age on nineteen, a piece of dead bone worked out through the fistula in the right groin. This bone was about the size of a lead pencil, and about 1 inch long. No stone, hair or other foreign body came through this fistula and no urine escaped at this time, but about five years later he began to have frequent leakage of urine through the sinus.

At this time there was no bladder trouble, no frequency, difficulty or pain. In 1904, at the age of thirty-four, he began to have pain in the bladder and shortly after, urine began to escape through the fistula in the groin. At times it was continuous and at other times it would cease for a period.

The frequency and pain in the bladder increased and at the end of two years was fairly considerable. He was admitted to the Johns Hopkins Hospital in 1906, was operated suprapubically and a stone the size of a chicken egg removed. No operation was done on the urinary fistula in the groin. About two weeks after leaving the hospital the patient returned with pain in the bladder and another stone was detected and crushed. After that the patient had no further pain in the bladder for three years, but urine continued to flow from the fistula in the groin.

On January 29, 1909, the patient came to the urological dispensary stating he had been passing stones with hairs attached to them at intervals for about a year. In one instance a hair eighteen inches in length came away with the calculus. In two other cases a calculus one inch long surrounding hairs had been passed. Cystoscopy was carried out and a long slender stone was seen hanging from the anterior wall of the bladder (fig. 16), apparently being held there by a hair which protruded from an opening which was visible on the anterior wall of the bladder. On March 10 this stone was removed with my cystoscopic rongeur by Dr. Geraghty. The hair was found to be about 3 cm. in length and surrounded by a calculus. Subsequently stones again formed and were seen hanging by hair from the anterior wall of the bladder. They were broken loose, crushed and evacuated. It was possible to pass a filiform through a fistulous opening in the right side of the perineum and the cystoscope showed that this filiform passed into the bladder through the opening from which the hair protruded and from which on various occasions calculi were seen to be suspended.

On June 5, 1910, he was admitted to the hospital (J. K., No. 2566, Brady Urological Institution) and operation was carried out by me on

June 17 under nitrous oxide. After opening the bladder suprapubically, the fistulous opening was found to be about 1 cm. in diameter and on the anterior wall about 2 cm. in front of the prostatic orifice, slightly to the right of the median line (fig. 16). I inserted a finger into this orifice and felt an irregular calculus which was removed with the curette. This process was repeated and additional *calcareous material which contained hair was removed*. The total amount of calculus was about 1.5 cm. in diameter. Examination then showed a peculiar septum of bone which ran from one pubic ramus to the other, and between it and the pubic arch lay the cavity which contained the stone and hair above described. With bone forceps this bridge of bone was removed as completely as possible, but owing to its great depth, it was impossible to remove it all. Examination of the bladder showed nothing particularly abnormal. There was no stone present in the bladder. After excising the edges of the fistula, the bladder, was closed up to the vertex where drainage was provided by a large tube.

Convalescence. Patient had satisfactory convalescence and was discharged in good condition, but on March 6, 1913 he again returned to the hospital complaining of pain and the passing of calculi. Cystoscopy showed another calculus attached to the anterior wall of the bladder. This was removed by crushing, and on various occasions subsequent to this, patient returned with a history of passing calculi and several times stones were removed by litholapaxy.

Patient was next admitted to the hospital on April 22, 1920, J. C., No. 8808 Brady Urological Institute, complaining of frequency of urination, hematuria, suprapubic pain and dribbling of urine from a fistula in the groin. Cystoscopy showed a contracted bladder which was markedly inflamed but no stone was present. A fistulous opening was seen on the anterior wall of the bladder.

On May 3, 1920, under nitrous oxide, oxygen and ether, I carried out a suprapubic and perineal excision of the vesico-perineal fistula (fig. 17). The bladder was sutured with chromicized catgut, a large drainage tube provided at the upper angle. The deep perineal suprapubic tissues were sutured with two layers of continuous chromicized catgut and the skin of the perineum and groin closed with continuous chromicized catgut, leaving a small point for drainage. At this operation no stone was found either in the bladder or along the fistulous tract. No hair or bone was detected.

On June 9, patient was discharged. The wound in the groin was healed and the suprapubic wound was very small only a few drops of

urine escaping through it. Patient was able to retain urine two or three hours without pain.

On July 6, 1920, the patient again returned with a fistula in the groin, and a probe detected rough bone, but when the wound was thoroughly curetted, no bone or tissue was obtained.

May 31, 1922. Since last note the fistula has opened from time to time, but no stones have formed since the operation in 1920. The urinary fistula has now been closed for six weeks and patient voids urine freely without pain or discomfort. He has passed no hair, calculi or bone fragments since operation in 1920. The prostate is about normal in size, smooth and elastic. The seminal vesicles are slightly indurated and adherent, and the fistula is apparently closed. Urine is still cloudy. Cystoscopic examination negative.

Remark. Accurate analysis of this case is difficult. It is quite possible that the history of accident at the age of nine is correct and that a fracture of the pelvis occurred which resulted in the bony exostosis which was found at operation in 1910; but this would not account for the presence of hair which was so frequently found surrounded by calculi and which was also found in the cavity adjacent to the bone at operation. Cleaning out this cavity and partial excision of the bone stopped the passage of hair, but calculi continued to form until a more radical operation was carried out in 1920. The frequent reopening of the fistula, however, would seem to indicate the continued presence of dead bone which can in fact, be felt with the probe and which is, I believe responsible for the recurrent perineal leakage. A still more radical operation will apparently be necessary to completely cure the recurrent urinary fistula.

GROUP IV. INCONTINENCE OF URINE ASSOCIATED WITH EPISPADIAS

This form of incontinence is not rare with epispadias, but very little concerning it has appeared in the literature. We have encountered this condition in three cases of epispadias, and examination in all these cases has shown a widely dilated urethra with absence of musculature along the superior wall, not only in the region of the prostatic urethra, but also in the region of the membranous urethra and triangular ligament. Urethrosopes and cystoscopes showed a marked dilatation of both internal and external sphincters (fig. 18) and the operative problem which was presented was to excise sufficient tissue in

order to tighten the urethra and restore sphincteric control of both external and internal sphincters. The operation which has been carried out is graphically shown in the accompanying illustrations (figs. 19-25). As seen here (fig. 19), a suprapubic incision was first made, and when the bladder was opened, a widely dilated prostatic orifice was seen, (insert A) in the depths of which the verumontanum could be made out. Examination showed that the superior wall of the urethra was thin and fibrous, and the finger could be passed out from the bladder through the dilated prostatic urethra and also through the membranous urethra into the deep bulbous urethra where it was met by a finger passed through the penile defect from without. It was thought necessary not only to excise the roof of the prostatic urethra but to continue this excision downward so as to include the roof of the membranous urethra, and in doing this it was found helpful to make a part of the excision through the dilated penile defect, as shown in figure 20. After sufficient tissue had been thus removed from the bulbous urethra down to the vesical cavity, approximation of the urethra was obtained by means of the Boomerang needle holder, first along the roof of the membranous and prostatic urethra through the suprapubic wound, as shown in figure 21, and also through the penile defect, as shown in figure 22. When this was completed, the urethra had been tightened at the prostatic orifice so as to resemble a normally closed internal prostatic orifice, and only a small instrument could be passed through the membranous urethra. No attempt was made in the first two cases to close the penile defect (epispadias) but suprapubic drainage was maintained for about three weeks in order to facilitate closure of the sphincteric plastics. At a subsequent operation the repair of the epispadias was carried out by means of the technique which has previously been published by the author.⁴ The results obtained in these three cases have been satisfactory, as shown in the accompanying abstracts.

⁴ Young, H. H., A new operation for epispadias. *Jour. Urol.*, ii, no. 3, June, 1918.

Young, H. H., An operation for the cure of incontinence associated with epispadias. *Jour. Urol.*, vii, no. 1, January, 1922.

Case 8. V. W. C. Age eighteen. No. 8583, Brady Urological Institution. Admitted March 3, 1920, complaining of deformity of penis and incontinence of urine (for complete history see Jour. Urol., vii, no. 1, January, 1922). On account of the complete epispadias and widely opened urethra, patient has not attempted sexual intercourse. Testes and epididymides were normal. Condition present is shown in figure 18.

Cystoscopy showed a markedly dilated prostatic orifice and also external sphincter.

On October 8, 1920, operation was carried out by the writer under nitrous oxide, oxygen and ether. The vesical orifice was found widely dilated and the verumontanum could be seen. A finger passed through the penile defect and met a finger passed through the prostatic urethra. There was practically complete absence of musculature anteriorly and the operation described above was carried out, the excision along the anterior wall being sufficiently extensive to reach muscle on each side and to make a fairly tight urethra both at the prostatic orifice and also in the membranous region when sutured. Suprapubic drainage was supplied but a catheter was not placed in the urethra.

During convalescence 1 per cent mercurochrome was injected in very small amounts through the suprapubic catheter and a few drops into the bulbous urethra. Infection was thus prevented. At the end of a month, the patient was able to void through the epispadias and had fair control. On December 8, a plastic operation to cure the epispadias was carried out according to the previously published technique which is shown in figures twenty-three and twenty-four.

On January 10, 1921, the following note was made: Suprapubic drainage continued; occasionally patient is able to void through the newly formed urethra and has good control.

February 11, 1921. Filiforms, followers and sounds passed into the bladder. Suprapubic sinus completely closed. Patient is able to void naturally.

May 17, 1921. Patient returns for observations. He is able to retain urine all night and voids at normal intervals during the day; has complete control. Libido and sexual powers are quite normal. Examination shows a normal looking glans penis with scar along the dorsum fig 25. Patient voids urine in a large stream, has perfect control and urine is sterile.

One year later. Patient reports condition as detailed above has been maintained.

Case 9. L. H. Age nine. No. 7677, Brady Urological Institute. Admitted April 23, 1919, complaining of deformity of penis and incontinence of urine which has been present since birth; otherwise entirely well. Scrotum and testicles normal. X-ray shows a wide separation of the symphysis pubis. Cystoscopes and urethroscopes show urethra to be widely dilated in both the membranous and prostatic portions. Prostatic orifice is largely dilated.

At operation on May 9, 1919, under nitrous oxide, oxygen and ether, a similar operation was carried out. The prostatic orifice was widely dilated and the verumontanum visible, and operation was directed against mainly the prostatic urethra which was excised along the roof as in a previous case, but the excision was carried deep enough to remove the roof of the dilated membranous urethra, and sutures were placed so as to draw together the muscle in this region as well as to form a tight prostatic urethra and internal vesical orifice. The anterior wall of the bladder was closed by continuous chromicized catgut sutures with drainage at the upper angle.

Convalescence. Suprapubic drainage was maintained for three weeks and then allowed to close, after which the patient voided urine naturally through the urethra. Four weeks after operation he was able to retain urine four hours, voided freely and with good control.

May 2, 1920. Patient returned for plastic cure of epispadias which was carried out as previously described, perineal urethrotomy with catheter drainage provided and maintained for eighteen days. At the end of a month patient was voiding urine normally through the newly formed penis with complete control at intervals of four hours. Plastic results excellent; appearance of penis almost normal.

May 15, 1921. One year since operation. Patient is able to retain urine for four hours and has perfect control. Has not had instruments passed since operation. General health excellent.

Case 10. F. H. Age twelve. No. 9659, Brady Urological Institution. Admitted May 10, 1922, complaining of complete epispadias and incontinence of urine, present since birth. At a previous operation partial urinary control had been obtained, but when the suprapubic opening was made, the internal orifice was found to be somewhat dilated and it was thought best to excise the roof of the urethra and make a much more extensive dissection, particularly in the region of the membranous urethra and triangular ligament. In this case the sutures were placed beneath the pubic arch from the penile side with the Boomerang needle

holder, the first stitch being placed at the prostatic orifice and continued downward along the prostatic and membranous urethra and a part of the bulbous urethra until the urethra had been brought together tightly around a ureteral catheter which was left in situ. This line of sutures was reinforced by one or two stitches beneath the symphysis pubis. Inspection suprapubically then showed a tight vesical orifice and the bladder was closed by a continuous chromicized catgut suture with drainage at the upper angle. Plastic operation to close the epispadias was carried out at the same sitting, by the technique previously described. An excellent plastic result was apparently obtained.

Convalescence. Ureteral catheter was removed from the urethra on the sixteenth day. Suprapubic drainage was maintained for thirty days. Patient began to void through the urethra on the twenty-second day and showed evidence of good control. Suprapubic wound closed on the thirty-fifth day and on the thirty-ninth day (now) patient is able to retain urine for one-half to three-quarters of an hour, voids freely with good stream and has no evidence of incontinence. The plastic of the penis shows an excellent result, urethra normally placed, glans and corpora cavernosa well approximated in front of the urethra; appearance almost normal.

These three cases of incontinence of urine, associated with epispadias and due to a congenital lack of sphincteric musculature along the anterior wall in the region of both internal and external sphincters, show that remarkable results can be secured when wide excisions and proper approximation of muscle are obtained and the sutures carefully placed. These cases and those of the previous three groups described above show conclusively that even after great traumatism, extensive destruction of both internal and external sphincters, and in the presence of much scar tissue, it is still possible by means of thorough plastic operations to cure incontinence and obtain normal micturition. In some cases the defect is posterior and excision of scar tissue and sphincteric plastics must be carried out along the floor of the urethra both through the suprapubic and perineal incisions. Where the defect is along the roof of the urethra as in epispadias, excision and plastic must be along the roof. Where incontinence is due to fistulae which parallel the urethra whether after fracture of the pelvis (group II), or from dermoid cysts of the prevesical

space (group III), the restoration of a normal urethra, excision of strictures and the closure of fistulae must be carried out, but if the internal and external sphincters have been injured, the operation must include plastic procedures to restore these sphincters as in group I. Each case is therefore a study under itself and the operation has to be varied according to the findings and conditions presented by the ten cases detailed briefly above, in which excellent results have been obtained. From these cases, some of which were of very long standing, had been frequently operated upon and were in a deplorable condition, it is sufficient to say that with appropriately radical resection and thorough approximation of the muscle, the sphincteric defects can be repaired and practically normal function of the newly-made sphincters can be obtained.

FIG. 1. CONDITION PRESENT IN POSTOPERATIVE INCONTINENCE

Both internal and external sphincter widely dilated. Scar tissue in perineum.

FIG. 2. VIEW OF BASE OF BLADDER SHOWING DILATED INTERNAL
VESICAL SPHINCTER

Insert *A* shows area denuded of mucous membrane, preparatory to suturing.

FIG. 3. "BOOMERANG" NEEDLE HOLDER

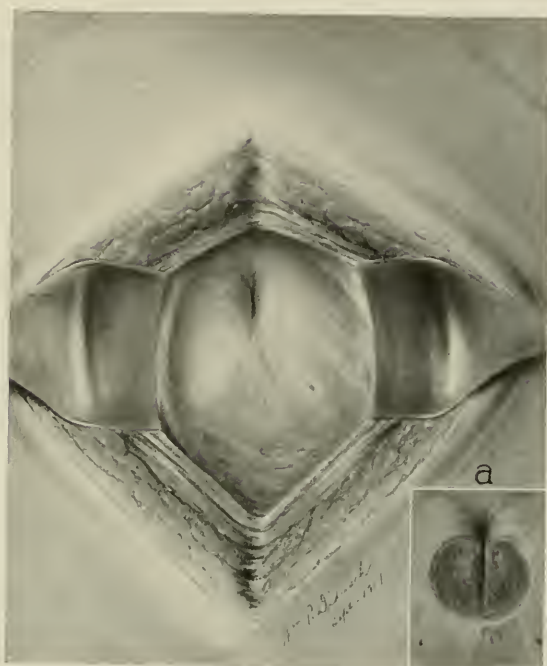


FIG. 2



FIG. 3

FIG. 4. THE NEEDLE HAS ENTERED THE TISSUE AND RETURNED, POINTING
TOWARDS THE OPERATOR



FIG. 4



FIG. 5. NEEDLE HAS BEEN PULLED BACK BY RELEASED SPRING IN HANDLE
OF INSTRUMENT, DRAWING SUTURE BACK THROUGH TISSUES



FIG. 5

FIG. 6. SUTURE-LINE AFTER COMPLETION OF PLASTIC OPERATION UPON
INTERNAL SPHINCTER

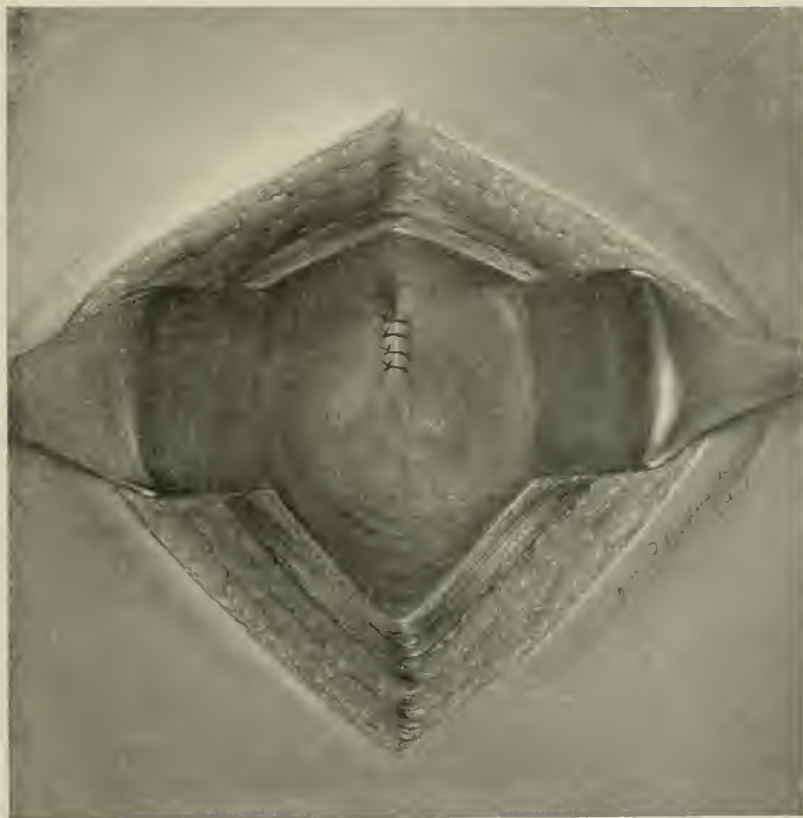


FIG. 6

FIG. 7. SHOWING INCISION IN PERINEUM TO EXCISE SCAR TISSUE PRELIMINARY
TO SECONDARY PLASTIC

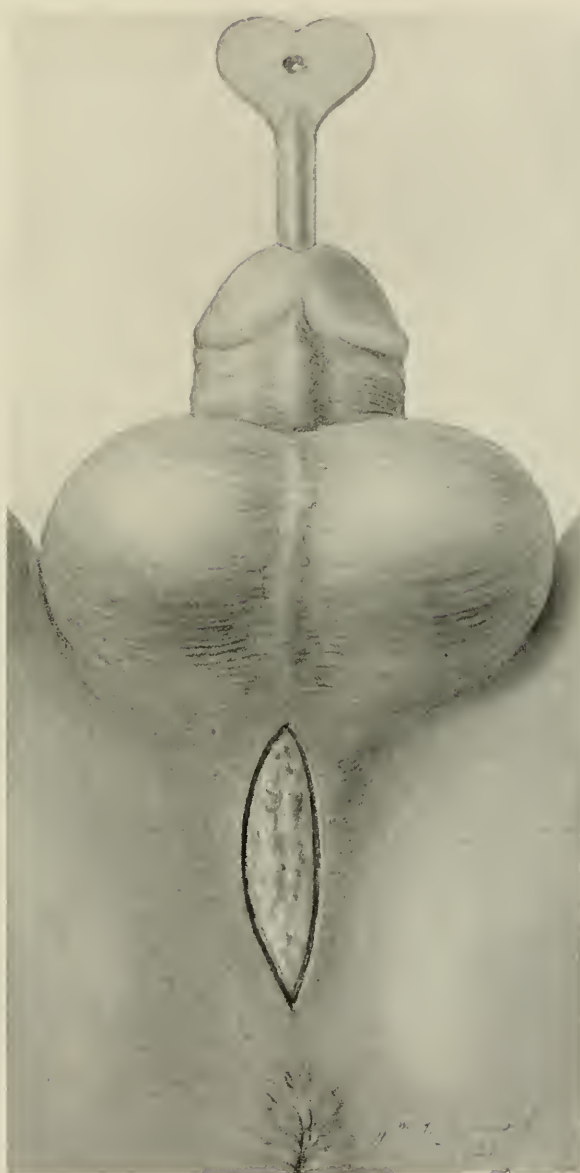


FIG. 7

FIG. 8. SHOWING DEEP DISSECTION AND EXPOSURE OF MUSCLE DURING EXCISION
OF SCAR TISSUE



FIG. 8

FIG. 9. EXCISION OF REDUNDANT URETHRA IN REGION OF TRIANGULAR LIGAMENT
AND EXTERNAL SPHINCTER

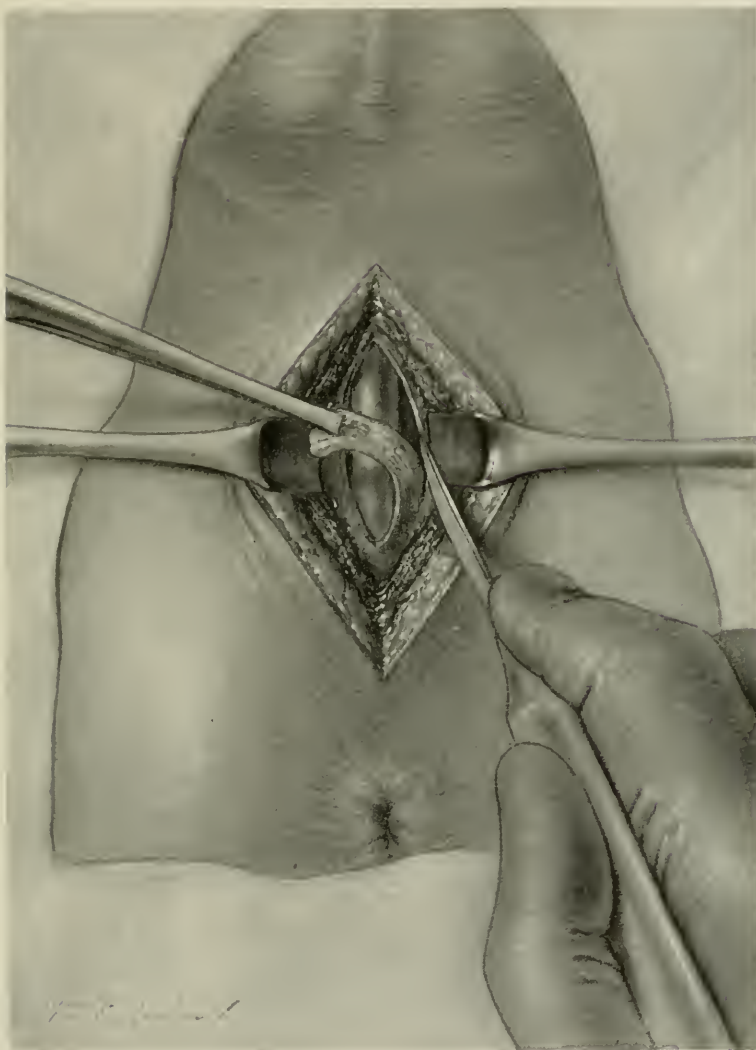


FIG. 9

FIG. 10. CLOSURE OF MEMBRANOUS URETHRA WITH "BOOMERANG" NEEDLE HOLDER

Mucous membrane inverted. Insert *A*, approximation of deep perineal muscle around urethra; insert *B*, closure of superficial muscle and fascia. Skin left open.

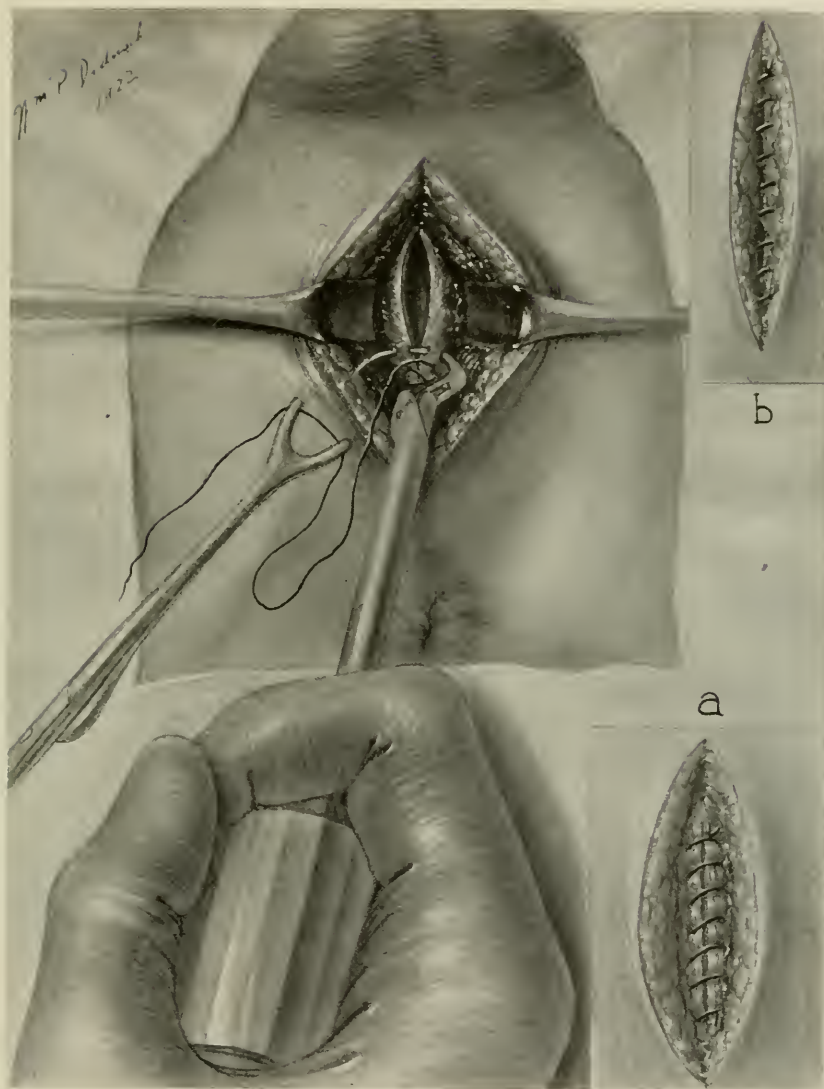


FIG. 10

FIG. 11. LONGITUDINAL SECTION SHOWING PRESENCE OF VESICAL AND URETHRAL CALCULI AND FISTULA PARALLELING PROSTATIC URETHRA AND LEADING FROM ANTERIOR WALL OF THE BLADDER TO THE BULBOUS URETHRA

Both internal and external sphincter dilated. Perineal fistula



FIG. 11

FIG. 12. SHOWING INTERNAL ORIFICE OF PREPROSTATIC VESICAL URETHRAL
FISTULA
Prostatic orifice dilated

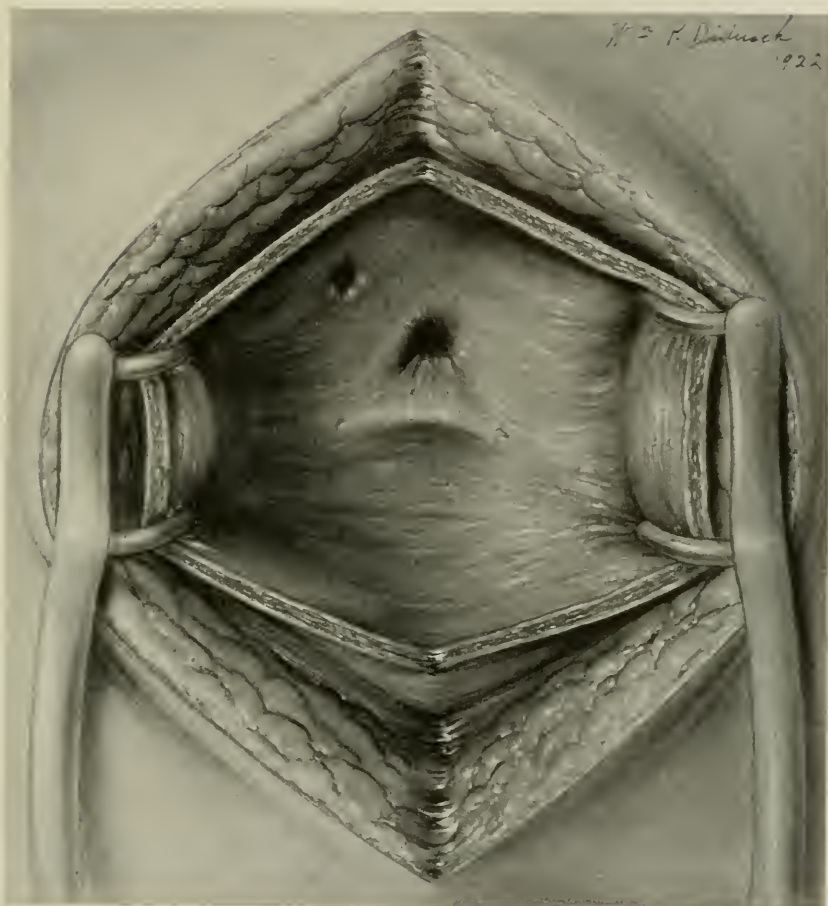


FIG. 12

FIG. 13. *A*, EXCISION OF FISTULOUS TRACT; *B*, CLOSURE OF VESICAL ORIFICE OF FISTULA

FIG. 14. LONGITUDINAL SECTION SHOWING PREPROSTATIC VESICAL URETHRAL FISTULA WITH TWO ORIFICES IN BLADDER
Obliterating stricture at apex of prostate.



FIG. 13



FIG. 14

FIG. 15. *A*, EXCISION OF MARGINS OF FISTULAE AND INTERVENING SEPTUM; *B*,
CLOSURE OF VESICAL ORIFICES OF FISTULAE IN TWO LAYERS

FIG. 16. SHOWING THE SLENDER CALCULUS SURROUNDING HAIR WHICH PRO-
TRUDED FROM PREVESICAL SAC

A, Showing the relation between this hair and cysted calculus of prevesical
dermoid cyst, as found subsequently at operation.

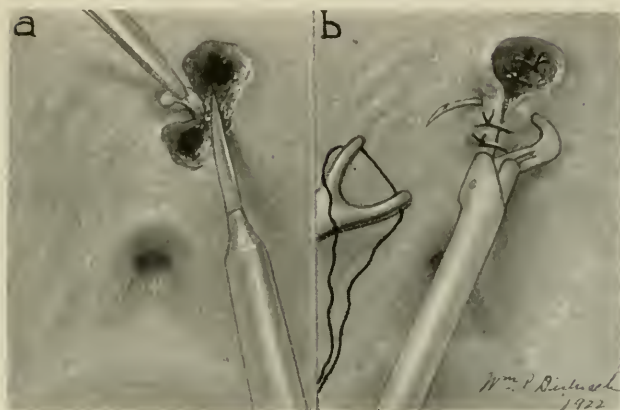


FIG. 15

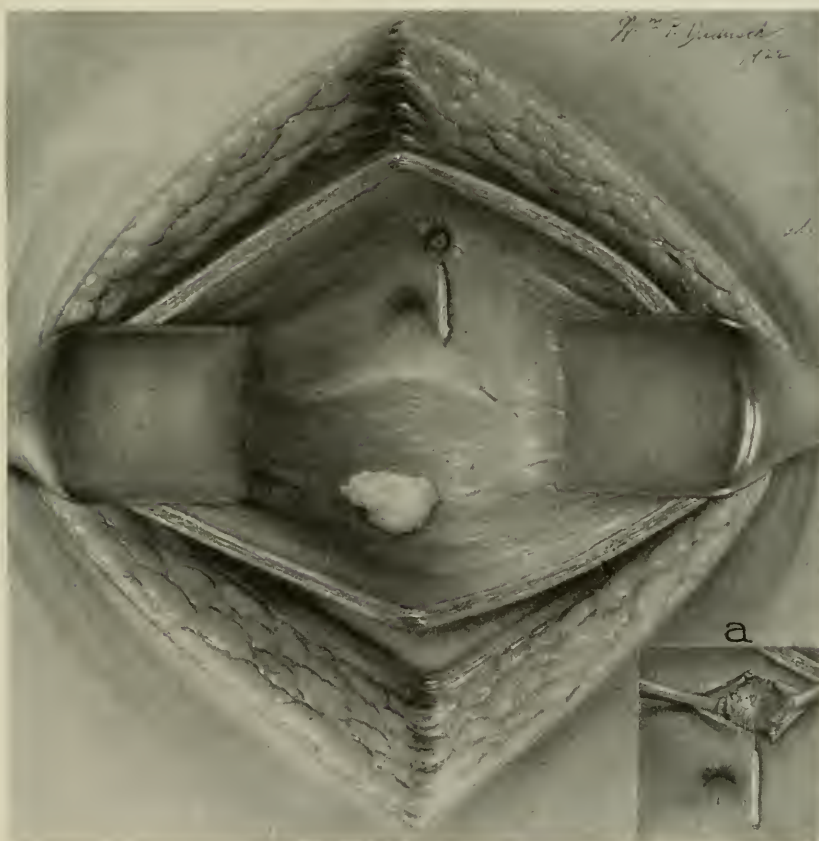


FIG. 16

FIG. 17. LONGITUDINAL SECTION SHOWING THE COURSE OF FISTULA FROM BLADDER
TO GROIN WHICH WAS COMPLETELY EXCISED AND CLOSED INTERNALLY
AND EXTERNALLY



FIG. 17

FIG. 18. SECTIONAL VIEW TO SHOW THE DILATED PROSTATIC ORIFICE (INTERNAL SPHINCTER) AND MEMBRANOUS URETHRA (EXTERNAL SPHINCTER)



FIG. 18

FIG. 19. A, DILATED CONDITION OF PROSTATIC URETHRA AND ATROPHY OF THE TRIGONE

Excision of anterior wall of dilated prostatic urethra also shown

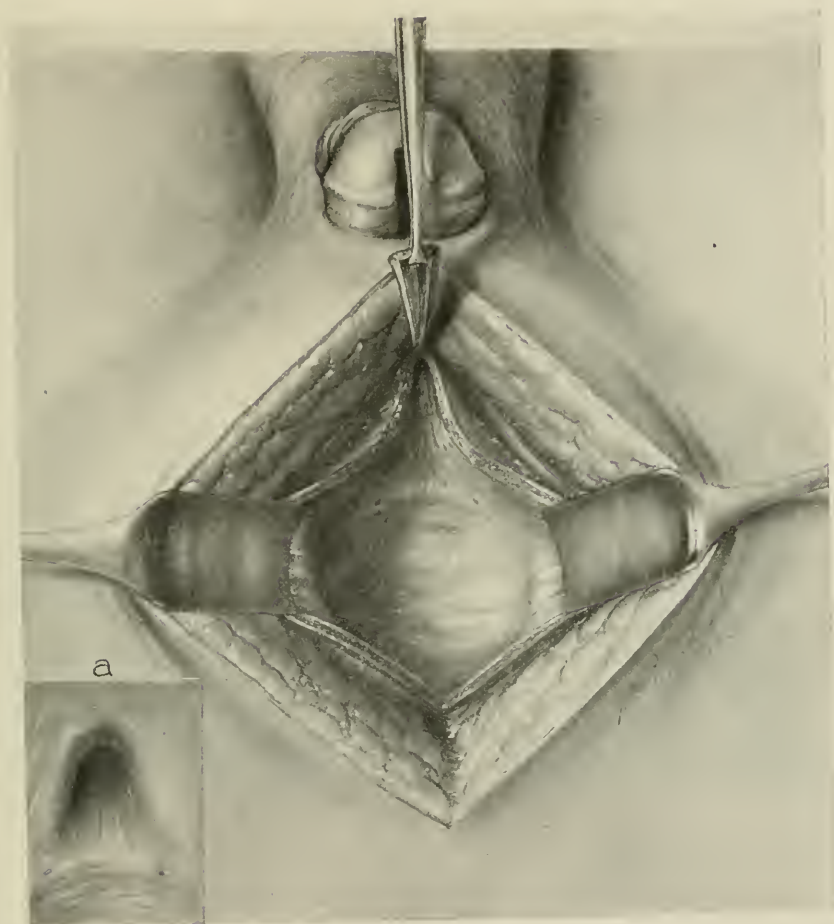


FIG. 19

FIG. 20. THE ROOF OF MEMBRANOUS URETHRA EXCISED THROUGH
EPISPADIAC CAVITY



FIG. 20

FIG. 21. SHOWING THE APPROXIMATION OF CUT EDGES OF PROSTATE
"BOOMERANG" NEEDLE HOLDER AND RESULTANT CLOSURE OF
PROSTATIC ORIFICE

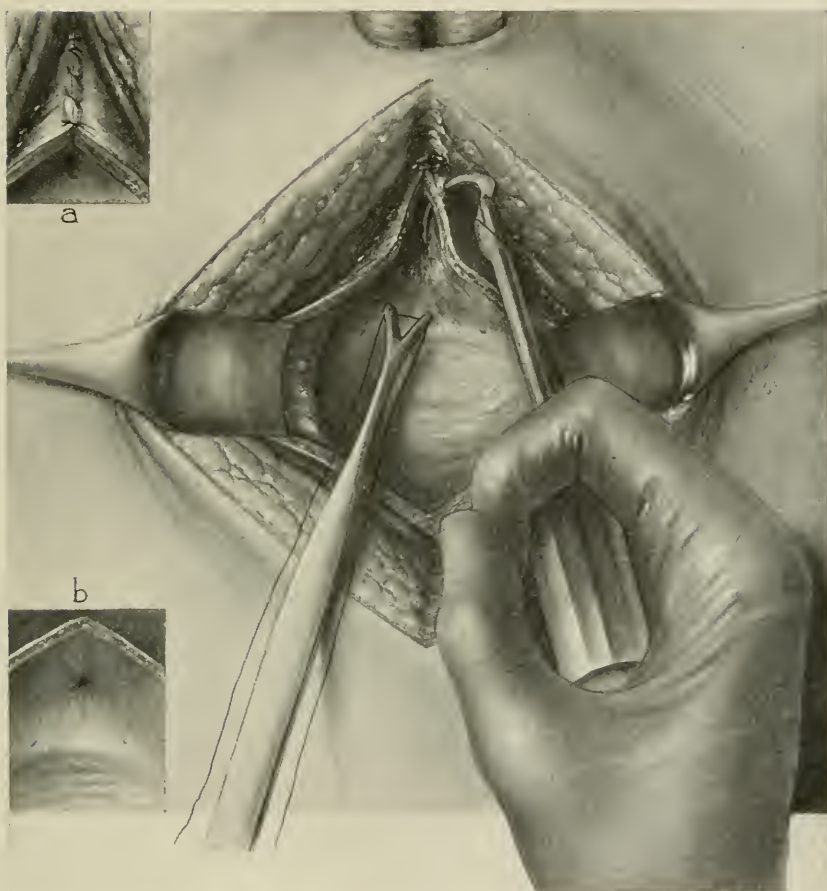


FIG. 21

FIG. 22. APPROXIMATION OF ROOF OF MEMBRANOUS URETHRA WITH CONSEQUENT
CLOSURE OF THE EXTERNAL SPHINCTER



FIG. 22

FIG. 23. THE NEW URETHRA IS BEING FORMED BY CONTINUOUS SUTURE,
BRINGING TOGETHER, OVER A CATHETER (*Ca*), THE EDGES PRO-
DUCED BY THE ORIGINAL INCISION, AND CONVERTING THE
ORIGINAL GROOVE INTO A TUBE

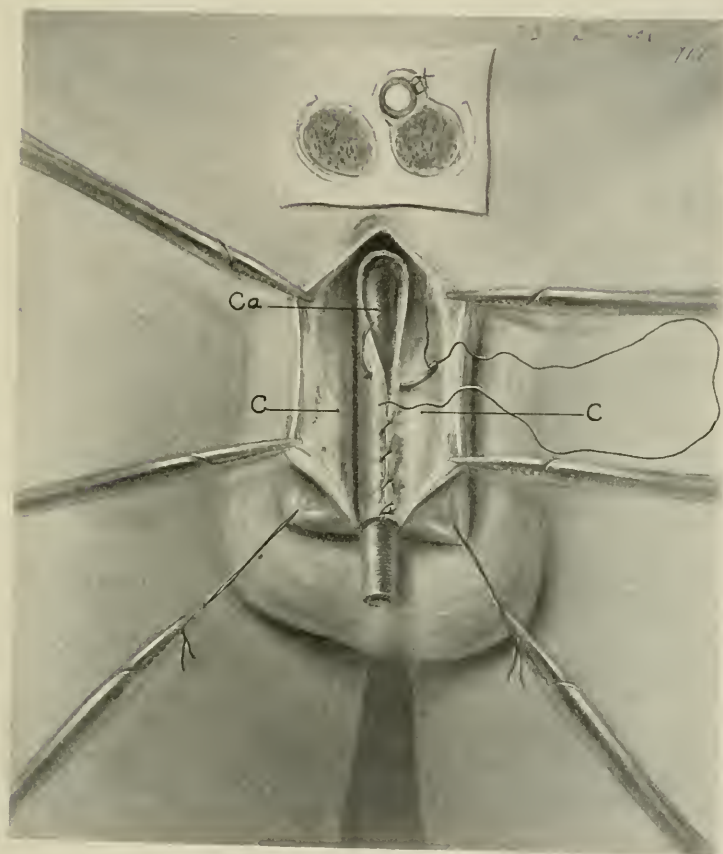


FIG. 23

FIG. 24. THE OPERATION COMPLETED

The two outer edges of the original incision were easily brought together at the midline making a penis and glans almost normal in appearance.

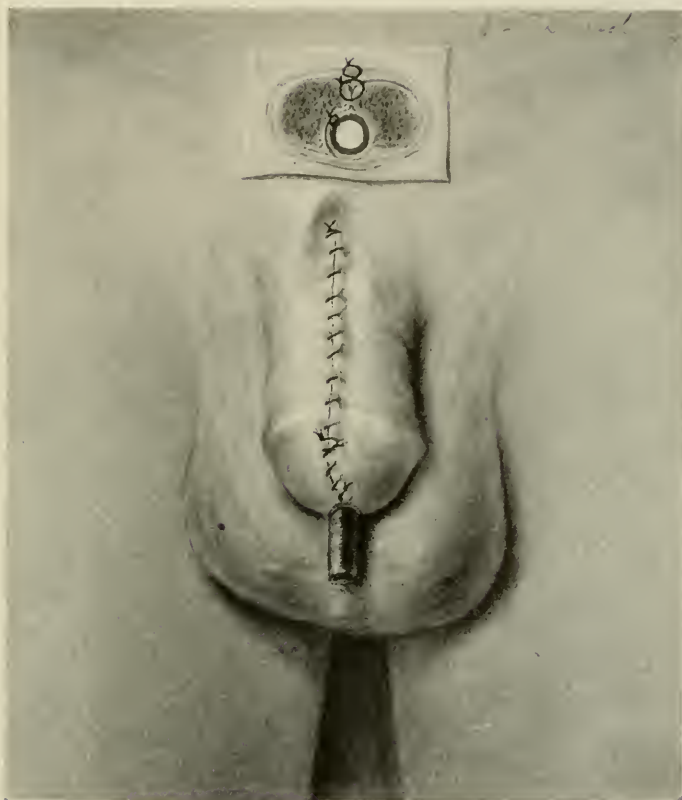


FIG. 24

FIG. 25. RESULT SEVEN MONTHS AFTER CURE OF EPISPADIAS
No fistula, no stricture, perfect urinary control, sexual powers normal

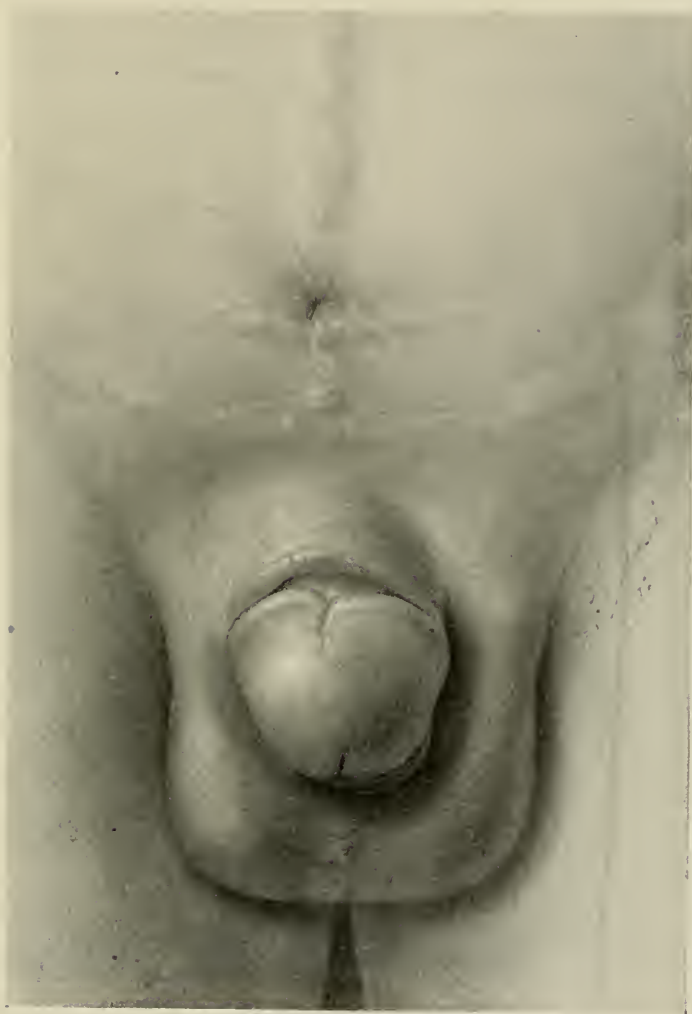


FIG. 25

THE PATHOLOGY AND MECHANISM OF PROSTATIC HYPERTROPHY

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The progress made in the pathology of the prostate in the last few years necessitates a revision of older views. In the following an attempt is made to summarize the new conceptions in the pathology and mechanism of the changes that occur in prostatic hypertrophy.

THE PATHOLOGICAL ASPECT OF PROSTATIC HYPERTROPHY

It is universally conceded that the term prostatic hypertrophy does not cover the pathological process intended to be conveyed by this term. Recent writers have furnished convincing evidence to the effect that it is not the prostate which undergoes hypertrophy. Our attention has been called particularly to a group of glands which were first described by Littré and Aschoff as the peri-urethral or submucous glands and which apparently undergo proliferation in later life. According to Simmonds, whose conception on the subject may be considered as the most advanced, the prostate, in contradistinction to the submucous glands, undergoes presenile changes similar in character to those observed in other organs in advanced life; the prostate atrophies, while the submucous glands undergo hypertrophy. In other words, Simmonds' conception is that presenile atrophy of the prostate is to be considered as a physiological process which is associated with enlargement of the rudimentary sexual (peri-urethral) glands as a secondary phenomenon. Simmonds is of the opinion that these changes are brought about by the internal secretion

of the preserved testicular substance which, in association with the primary atrophy of the prostate, stimulates the peri-urethral glands to growth.

The proliferating peri-urethral glands spread in various directions and thereby intrude upon the prostatic gland, which in consequence of compression undergoes further atrophy. This process may gradually develop to such an extent that the prostate appears often as a pseudocapsule of the growth about 0.5 cm. and less in thickness, in which remnants of the prostatic tissues can be readily demonstrated by microscopic examination. This proves beyond doubt that as far as the prostatic gland itself is concerned, the process is an atrophy rather than a hypertrophy.

Aside from these considerations the term "hypertrophy" is a misnomer from another point of view.

As is generally accepted, the term hypertrophy denotes a simultaneous enlargement of the various structures of an organ. Such a process is generally not observed in pure prostatic hypertrophy which exhibits a hyperplasia of the glands with no deviation from the normal structures. These considerations justify the definition of prostatic hypertrophy as a nodular hyperplasia of the peri-urethral glands which are located between the verumontanum and the internal sphincter.

The long continued discussion, as to whether adenomata or fibromyomata are the predominating features, is of no real importance, as we know that there exists no pure formation of either type, that the softer, so called adenomatous type which is observed in about 90 per cent of the cases may be considered as a rule, while the hard sclerosed nodules or the more generalized fibrosis are rather secondary inflammatory or congestive changes caused by the growth or other pathological processes involving the prostate. Primary neoplastic proliferation of any of the prostatic tissues is a separate pathological entity and should be differentiated from the above condition disregarding the fact that the clinical symptoms may speak for similarity.

All this suggests a radical change in our conception of the prostatic affection dealt with in this paper.

Of itself the hyperplastic process of the glands cannot be considered as a pathological process. It is no more a disease than is gray hair.

It is with the secondary changes elicited by the growth in the neighboring organs and with the appearance of obstruction that the true pathology begins. These pathological changes may be looked upon from the topographical point of view as changes in the urethra, changes in the bladder and in the upper urinary tract, growing out gradually from a local condition into a general systemic disease which eventually may involve all the organs of the system.

THE MECHANISM OF THE CHANGES IN THE URETHRA OCCURRING IN PROSTATIC HYPERTROPHY

The expansion of the proliferating glands encounters several mechanical hindrances. Towards the perineum the diaphragma urogenitale presents an unsurmountable barrier. At the posterior surface the prostate is quite an important obstacle, more pronounced in some cases than in others; and the only direction of little resistance is towards the bladder. This direction is along the prostatic urethra, which in order to keep pace with the proliferating glands, undergoes numerous changes in regard to size, lumen and curve.

As is known, the posterior urethra is by no means of a homogenous structure. It is fixed at the membranaceous segment by means of a powerful muscle and the only part which can be moulded in different shape and sizes is the very segment located between the ejaculatory ducts and the internal sphincter.

The floor of the urethra with its glands will necessarily undergo most of the changes, while the roof of the urethra exhibits more secondary and relatively insignificant changes. This suggests the existence of a complicated mechanism, acting in numerous ways and under various influences, to which a few remarks will be directed.

The glandular growth, as will be seen later, shows a tendency to raise the floor of the bladder either in toto, or in segments, a condition which is usually associated with upward dislocation

of the sphincter internus. The topographical position of the sphincter however cannot be altered without affecting the length of the urethra; which fixed at one point and dragged on at the other, must undergo stretching and elongation varying between 1 to 4 cm., and still more in extreme cases. The posterior wall of the prostatic urethra will be more elongated than the anterior, thus giving rise to a disproportion in the antero-posterior diameter, counterbalanced by distortion of the normal curve. Stretching of the urethra in sagittal direction causes in turn narrowing of the transverse diameter and a cleft like enlargement in the sagittal diameter. It is evident that all these changes cannot remain without affecting the normal urethral curve which in addition is complicated by a more or less abrupt excavation at the base of the changeable prostatic urethra and by a pouch-like depression at the point where the urethra encounters a raised, overgrown and distorted sphincteric region.

In cases of so called prostatic invasion into the lumen of the urethra, which is usually marked by one sided or both sided lateral protrusions of the growth, a new factor has to be taken into account. In general with either one protrusion a dilatation of the opposite wall goes hand in hand, and in more pronounced cases the prostatic urethra may assume an irregular, tortuous or S-like curve with as many pockets and blind sacks as there exist projections of the growth. This to an extent explains the danger of catheterization with stiff instruments and the use of special double curved catheters in advanced cases. Furthermore, double sided invasion is often accompanied by symptoms of pseudo-stricture seen in cysto-urethroscopy as a narrow cleft-like channel compressed between two lateral lobes which may be entirely overlapping the verumontanum. It is plausible that such considerable changes as described are liable to affect the structures of the urethral walls and especially its complicated muscular apparatus.

The muscular apparatus of the urethra, which has been known to consist of the urethral cut-off muscle and of a layer of unstripped muscle embedded between the meshes of the former, according to some authors, is supplied with additional muscle fibers from the vesical detrusor. This new muscle is known in literature as the

longitudinal muscle of the urethra. The longitudinal muscle which seems to play an important part in micturition, in shortening the urethra and keeping its lumen open during the process of voiding, is usually one of the victims of prostatic hypertrophy. The growth may press either directly upon the muscle, or impair its elasticity indirectly through stretching of the urethra and thus contributing its share to the symptoms of difficult micturition. Other muscles likewise undergo gradual changes, and finally the powerful sphincter externus which in order to compensate the deficiency of other co-operating and antagonistic muscle groups is being kept under constant strain, may weaken gradually and be subjected to fibro-sclerostic changes. In these cases the entire urethra may present a uniform sac which readily gives way to mechanical pressure.

EFFECTS ON THE BLADDER

From the anatomical point of view two types of prostatic invasion are observed in the bladder.

In bladders with a resistant sphincter and a less resistant trigon the growth raises the floor of the bladder, but does not derange the structures of the sphincter directly and does not disturb the symmetry of the bladder in any way.

The second type which means direct involvement of the sphincter, occurs usually in cases where the proliferating glands near or at the sphincter encounter in their way a bladder outlet of less rigid structures and less resistant to moulding. From the latter a third group of the so called "middle lobe" formation may be distinguished, which presents the most developed type of prostatic obstruction.

In the first group of cases the sphincter, although not primarily involved, is being pushed upward with the floor of the bladder and ceases to be the lowest point in the bladder. This in combination with pressure of the residual urine favors the formation of a "bas fond." Where dislocation has taken place, the position of the trigon and the ureters to the sphincter may undergo considerable alterations, the ureters being found behind the sphincter or overshadowed to such an extent by its appearance,

that we may be unable to locate them with the cystoscope. With all these changes however taking place, the concave outline of the sphincter and its diametrical proportions are usually well preserved and undistorted.

Different conditions prevail in cases where direct invasion of the sphincter by the growth has taken place.

As seen in cystoscopy the outline of the sphincter may be irregularly distorted by several protrusions projecting into the bladder, or there may be seen intrusions of two or three lateral lobes which may be separated by a "V" like groove at the middle of the the sphincter; or finally there may be one lobular formation located at the lateral or central parts of the sphincter.

Marion gives the following statistical survey as to the frequency of each of the forms of prostatic invasion in relation to the sphincter.

Among one hundred cases in average, seventy have been classified as three lobular invasion, consisting of two lateral and one middle lobe; fifteen cases belong to the middle lobe type; ten exhibit two lateral lobes, and five do not show more than one lobe, which may be either a lateral or an anterior middle lobe, or be in irregular position. All these different types are associated with a definite derangement of the sphincteric structures and distortion of the bladder outlet, which may be of a more or less irregular shape according to the number, to the position, and to the size of the invading growths. The most notable changes are observed in cases of middle lobe invasion and the effects of obstruction are best studied in these cases.

It is fairly well established that the pathological middle lobe has nothing in common with the anatomical or Home's lobe, although many writers still continue to identify them. Its origin does not differ in character from that of other glandular hyperplasias, and the anatomical and pathological lobes are separated from each other by means of the sphincteric muscle.

The degree of obstruction which follows the middle lobe formation varies according to various factors. It is not only due to the special location of the growth which obstructs the bladder outlet, and far less to its size, which is quite frequently out of proportion

to the obstruction, but to a large extent the condition depends on the special position taken by and from the peculiar structure of the obstructing growth. In cases where the middle lobe takes a more straight position and is of softer consistency, we are usually confronted with less pathological complications than in cases distinguished by the horizontal position of a more rigid growth which exerts a lid-like function during the act of micturition. A soft pedunculated, readily movable growth is likely to give way on pressing, or the patient changing his position, while a rigid inelastic growth will defy all efforts. On the contrary, the more the patient strains, the closer the valve-like protrusion adheres to the adjacent sphincter, thus completing the vicious cycle. Internal pressure raises the obstruction, and congestion increases the rigidity of the lid, a condition likely to intervene in the event that the patient has disregarded an early call for urination, or in excesses of any kind which may be followed by symptoms of acute retention.

Whatever form the obstruction has taken, the obstruction once established, the bladder responds with considerable changes in its shape, size and structures of its walls, varying according to the degree of obstruction and to the capacity of the bladder to resist the effects of obstruction.

The shape of the normal bladder has often been compared with the shape of the heart with its apex tending towards the sphincter. In prostatics a reversed condition prevails and the apex of the oval shaped bladder tends toward the fundus.

The size of the bladder generally increases with growing retention and with progressing atrophy of the bladder walls and may reach immense dimensions in the final stages. The most important changes however are observed in the structures of the bladder walls.

Increased pressure requires increased labor in order to overcome the impediment, and continuous strain which means increased muscular activity, leads sooner or later to muscular hypertrophy. The detrusor grows out gradually from tiny strips to a powerful crisscrossing framework of elevated ridges and bands containing in its meshes smaller and larger excavations of the bladder wall,

a picture of the so called trabeculated bladder as seen in cystoscopy. Among the excavations we may find smaller, relatively shallow sacculations usually reaching to the muscularis and large diverticula, some of them being so deep that their base cannot be reached by the cystoscopic light. In other cases we may be confronted with deep pockets practically tied off from the bladder wall and communicating with its vacuum by means of ureterlike ducts. These tied off diverticula may reach considerable sizes. Usually all of the structures are involved in these formations, but quite often we may be confronted with excavations of an atrophic mucous membrane covered by a thin layer of degenerated muscular tissue or by a diseased serosa only, a condition calling for great care in catheterization.

However, the capacity of the bladder to bear insults is not unlimited, and with growing disproportion between obstruction and muscular efficiency the stage of active adaptation will be soon passed, giving way to inactivity. The overgrown bladder muscle shares the same fate as the hypertrophic muscle of the heart. Overwork, malnutrition, fibrosclerotic changes and atrophy, complicated at times with infection, and usually with toxic absorption, contribute their share in weakening the muscle gradually. Finally the bladder ceases to take active part in micturition, presenting an overdistended atonic sac which is unable to express even small amounts of urine; this condition is usually associated with symptoms of complete chronic retention and ischuria paradoxa.

Summing up the changes occurring in the bladder we may well say that the first stages of active bladder adaptation are inaugurated by irritation and derangements of the sphincter, which are accompanied by the sensation of a full bladder even after the bladder has been emptied of its contents. This is the stage of pseudo-obstruction not complicated by any considerable amount of residual urine or bladder distention, and is well counterbalanced by the increased activity of the bladder. The next two stages of true obstruction are associated with partial respectively total distension of the bladder walls and with residual urine. Retention is then the predominating feature of the disease, and is fol-

lowed by gradual loss of activity on the part of the overexposed bladder muscle. It is to be remembered however that any of the stages may simulate a more advanced stage in cases that are complicated by infection (cystitis, prostatic abscesses), acute retention, or a calculus obstructing the passage of urine.

Other changes which are confined to the trigon will be mentioned in connection with the changes occurring in the upper urinary tract.

CHANGES IN THE UPPER URINARY TRACT AND THEIR SPECIAL MECHANISM

One of the first symptoms observed in prostatics is nocturnal polyuria, an exquisite renal symptom due to congestion of the kidneys. Congestion is sooner or later followed by destruction, the pathology of which is undoubtedly one of the most interesting chapters in urology. Until recently the conception of the changes that occur in the ureters and the kidneys has been based on the theory of back pressure, due to retention.

As is known the ureters pierce the bladder wall in oblique direction which is in itself a certain protecting measure against urinary reflux, but reflux is still less probable during the act of micturition which is associated with increased intravesical pressure. The contracting bladder muscle supports the sphincters of the orifices in their cut-off function, and so a barrier is set up against reflux while the bladder is active. Nor is the atonic bladder a suitable medium for back pressure. One would rather think that back pressure in an atonic bladder is the more inconceivable the less intravesical pressure one expects in an atonic sac. This warrants the need of a revision of our former conception of the mechanism of back pressure which is supposed to cause urinary reflux by means of the vis a tergo of retention.

In endeavoring to find a solution of the problem, Tandler and Zuckerkandl directed their attention to the anatomical and pathological conditions of the trigon and the ureters, and although their conclusions have not met with unanimous approval, so far, they nevertheless deserve consideration.

As already pointed out the trigon, while presenting the most fixed part of the bladder and exhibiting no trabeculation, is nevertheless subjected to alterations which have considerable bearing on the changes met with in the upper urinary tract. It is obvious that with the trigon raised and dislocated by the growth, the intravesical parts of the ureters too will be found at a higher level. This altered position favors, in the opinion of Tandler and Zuckerkandl, the strangulation of the ureters by the crossing of the vasa deferentia. However, leaving this conception for further discussion, we must admit that further observations of the changes occurring in the trigon and the ureters furnish sufficient data to support the view that primarily we have to deal with a strictured condition of the lower segment of the ureters which is followed by a secondary enlargement of the parts above the stricture. The following few observations may be cited in support of this view.

Normally the orifices of the ureters are found at the ends of the interureteric ridge, which as a rule does not extend far beyond the orifices. A different condition is encountered in a bladder which has been chronically distended. With increasing distention, the interureteric ligament may appear enlarged and extends sometimes far beyond the orifices, the extension reaching twice the normal distance in some cases. That this enlargement is not a hypertrophy of the interureteric ridge, is proven by histological examination, which reveals beyond doubt, that the above condition relates to an elongation of the intramural parts of the ureters rather than to true hypertrophy of the ligament. The elongation of the ureters in association with alterations in their direction and in addition to the muscular changes of the trigon may indeed in many of the cases be responsible for the narrowing of the ureteral lumen. The value of the above findings has been particularly emphasized by Zuckerkandl, who suggested that whenever cystoscopic examination reveals a hypertrophy of the trigon and particularly an elongation of the interureteric ligaments, we are to conclude the existence of pathological changes in the upper urinary tract. Among other findings supporting this view, it may be mentioned that up to the later stages the orifices as a rule are rather small and in many cases we may not be in a position to

insert a ureteral catheter higher up than about 2 cm. above the orifices.

Whatever may be said about the mechanism of the retrograde changes which is still a matter of controversy, there can be no question about its pathological effects. The ureters and the renal pelvis being less elastic and less adaptable than the bladder, are unable to resist the long continued pressure without conveying it directly to the kidney substance. The capacity of the ureters and the renal pelvis is limited and so is their capability to store up residual urine in excess. The degree to which they can be distended is indeed little in comparison to the bladder, and sooner or later they are forced to increase their capacity at the expense of the softer kidney substance.

There are several stages to be noted in this respect. At first there occurs dilatation of the ureters and the renal pelvis, which by its pressing toward the center, may cause gradual dilatation and clubbing of the calyces (nephrectasis). In more severe cases this is followed by destruction of the kidney substance, starting in the softer pars medullaris and gradually involving the more resistant structures. Finally there may develop a stage where the kidneys have been transformed into a more or less uniform sac or several cysts filled up with fluid of low specific gravity (hydronephrosis), or pus (pyonephrosis) and covered with a small margin of tissue remnants, which are unable to excrete any considerable amount of solids (hyposthenuria), and of a low urea output (azotemia). However, the above course does not occur uniformly. There are cases where inflammatory and sclerotic changes in and around the kidneys set up a more or less dam like obstruction to the forces of pressure.

In others some congenital or topographical peculiarities of the renal pelvis, like its extrarenal position for instance, may cause a divergence of the point of the lowest resistance in some other direction, with the changes in the kidneys less marked than usual. This in association with a various degree of individual resistance explains the variety of symptoms confronted with in renal pathology.

SUMMARY

1. The progress made in prostatic pathology leads to the conclusion that the so called prostatic hypertrophy is really a hyperplasia of the peri-urethral glands. The prostate itself undergoes atrophy through compression by the growth intruding upon, or primarily as a physiological presenile process occurring in advanced life.

2. Prostatic hypertrophy cannot be considered as a disease. It is with the secondary changes in the urinary tract caused by proliferation of the peri-urethral glands that the true pathological process develops.

3. The changes in the urethra in regard to size, lumen and curve are the result of various coöperating and antagonistic forces, of which the direct pressure of the intruding glands, the indirect influence of the changes in the bladder upon the urethra and the anatomical peculiarities of the latter, are the most important factors. The part of the urethra which is directly subjected to moulding by the growth is the supramontane part of the prostatic urethra.

4. The muscular apparatus of the urethra suffers a gradual loss of elasticity. The most noticeable changes are observed in the so called "longitudinal muscle" of the urethra which is subject to direct pressure and distortion by the growth.

5. There may be distinguished two types of intrusion of the growth into the bladder. The direct invasion occurring on or near the sphincter of the bladder, which is associated with alterations in the symmetry of the bladder and the outline of the sphincter. This is not observed in the indirect invasions, which raise the floor of the bladder in toto without affecting its symmetry directly.

6. The pathological middle lobe formation has nothing in common with the anatomical or Home's prostatic lobe.

7. The mechanism of the alterations which take place in the bladder is the result of two antagonistic forces which are represented in the quality and the degree of obstruction and in the capacity of the bladder to resist the effects of obstruction. The

early stages of bladder involvement are marked by its increased muscular activity. In the later stages of growing disproportion between obstruction and resistance, distension and atony of the bladder are combined with impaired muscular activity.

8. The conception of back pressure as the primary cause of the changes occurring in the upper urinary tract is inconsistent with the anatomical and physiological peculiarities of the bladder and the ureters. Contraction of the bladder prevents rather than causes urinary reflux, and in an atonic bladder urinary reflux is still less probable.

9. According to Tandler and Zuckerkandel advanced bladder distension in prostatitis favors compression and narrowing of the ureters, which in turn may cause obstruction to the downflow of urine and be followed by secondary enlargement of the parts above the stricture.

10. The early stages or renal involvement occurring in prostatitis are marked by congestion of the kidneys, associated with nocturnal polyuria. They are followed by gradual destruction of the kidney substance with the symptoms of azotemia and hyposthenuria.

11. The cystoscopic picture of an enlarged interureteric ligament extending beyond the orifices of the ureters, as observed in the later course of prostatic hypertrophy, is suggestive of complications in the upper urinary tract.

The writer wishes to extend his thanks to Drs. Alfonse A. Wren, Chief of the Clinic, and Louis Chargin for their valuable suggestions and coöperation in connection with this work.

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CARCINOMA IN THE URETEROPELVIC JUNCTURE METASTATIC FROM THE PROSTATE

REPORT OF A CASE

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Metastasis from carcinoma of the prostate gland is usually detected first in the lumbar sacral region. In a series of 297 cases of carcinoma of the prostate gland in which routine roentgenograms were made, 84 (28.28 per cent) showed metastasis in the bones. The next most common site of metastasis is in the lymphatics which drain the prostate and thence follow the course of the large pelvic blood vessels along which are several groups of lymph nodes. The nodes at the bifurcation of the iliacs are usually the first to become involved. From these the lymph stream goes directly to a second group located on the sacral promontory and is borne hence along the perivertebral nodes. Extension by this route often occurs so rapidly that the supra-clavicular lymph nodes are involved before the original malignancy is suspected. In about 8.47 per cent of the patients in whom metastasis is demonstrable, the lymph nodes on the left side of the neck are affected. In the presence of these enlarged lymph nodes the stomach may be suspected of being the original focus, particularly in the 11 per cent of cases in which malignancy of the prostate does not produce urinary symptoms. Another form of metastasis which occurs but rarely with carcinoma of the prostate, is metastasis to the abdominal viscera

through the blood stream. In the case here reported, metastasis was found in the periprostatic and vertebral lymph nodes, and in the left kidney and the ureter, close to the renal pelvis.

Case A353501. Mr. G. A. T., aged sixty-three years, registered in the Clinic March 24, 1921, complaining of difficulty and frequency of urination of two months' duration. He voided every half-hour day and night, and finally, one week before admission to the Clinic, complete retention occurred and it was necessary to use a catheter. For eight months, he had had persistent so-called sciatic or rheumatic pain in the left leg. He had lost 50 pounds in weight.

Examination was negative, save for a hard, nodular enlargement of the prostate gland which seemed to be confined within the capsule. The phenolsulphonephthalein test showed a 33 per cent return of the dye; there was 20 mg. of urea in 100 cc. of blood.

Roentgenograms of the chest, spine, pelvis and femurs were negative, except for slight increased density in the sacro-iliac region. Radium treatment was recommended although the history of left sided sciatica indicated periprostatic extension. Since the main symptoms were due to retention, it was hoped that partial prostatectomy following radium treatment might give relief.

After the application of 1145 mg. hours of radium, the patient developed marked gastric, intestinal and cardiac symptoms, failed rapidly, and died six days later.

At necropsy, numerous metastatic, flat, grayish nodules varying from 1 to 5 mm. in diameter were found scattered throughout the pleura of both lungs. Some of these areas were surrounded by a bright reddish zone. Both lungs were crepitant throughout, and on section, the cut surface was grayish pink. Nodules extended into the substance of the lungs for 1 to 2 mm., and were also found scattered through the cut surfaces of the lungs.

The perivertebral lymph nodes along the lumbar-sacral region were extensively affected and covered the aorta from the bifurcation to the first lumbar vertebra.

The left kidney weighed 130 gm. The capsule stripped readily, leaving a red granular surface. In the superior pole was a grayish, wedge-shaped area 5 mm. in diameter and surrounded by a bright red zone. On section, this area was found to extend into the renal tissue for a distance of 1 cm. The pelvis of the kidney was moderately dilated. Two gray rounded

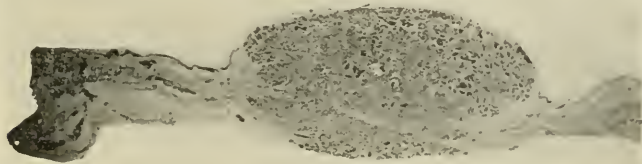


FIG. 1

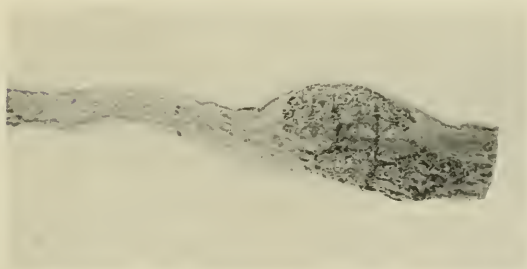


FIG. 2

FIGS. 1 AND 2. METASTATIC NODULES FROM THE LEFT URETER

nodules 3 and 6 mm. in diameter and 3 mm. apart were found in the ureter at the ureteropelvic juncture (figs. 1 and 2). On section, they were found to extend through the muscular wall but did not involve the serosa. The right kidney was free from evidence of metastasis.

The bladder did not present any gross abnormalities, except a rough granular area about 3 cm. in diameter in the base. The

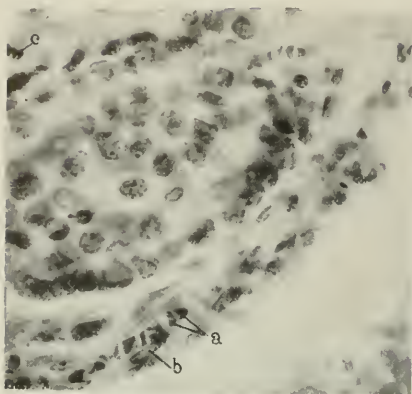


FIG. 3

FIG. 3. SECTION FROM THE LUNG, *a*, SHOWING LARGE BLOOD VESSEL FILLED WITH AND SURROUNDED BY CARCINOMA CELLS. *b*, RED BLOOD CELLS FLATTENED AGAINST THE WALL OF THE VESSEL. *c*, MITOTIC FIGURE OUTSIDE OF THE VESSEL WALL. $\times 500$

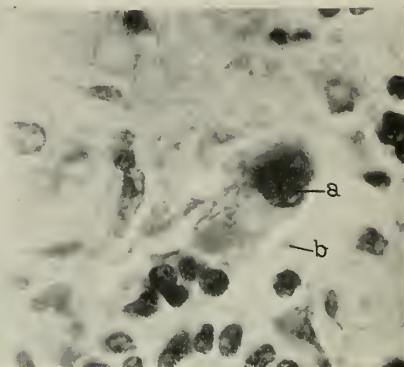


FIG. 4

FIG. 4. *a*, CARCINOMATOUS CELL IN BLOOD CAPILLARY NEAR THE RENAL INFARCT. *b*, ENDOTHELIAL CELL LINING THE VESSEL. $\times 1000$

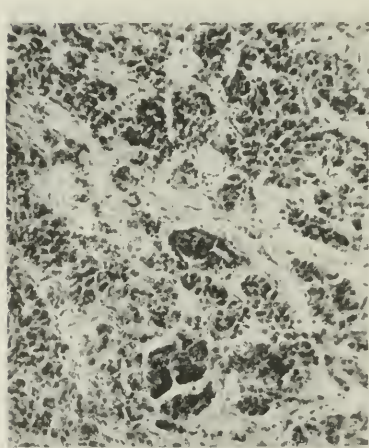


FIG. 5

FIG. 5. METASTATIC NODULE FROM THE LEFT URETER MADE UP OF EPITHELIAL CELLS HAVING ONLY A SLIGHT TENDENCY TOWARD ALVEOLAR FORMATION. $\times 100$

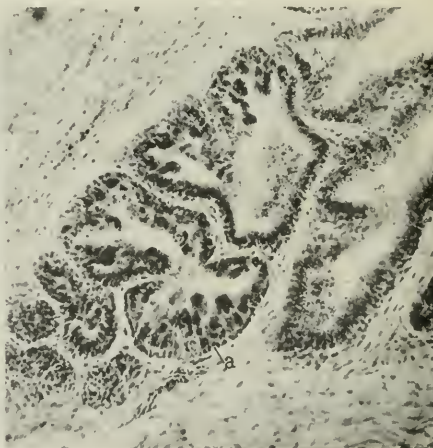


FIG. 6

FIG. 6. SECONDARY CYTOPLASIA OF THE INNER LAYER OF THE PROSTATE GLAND. *a*, INTACT OUTER LAYER. $\times 100$

prostate gland was moderately enlarged and could not be shelled from its bed. It was firm in consistency and the cut surfaces were gray and granular. The lymph nodes surrounding the prostate were also infiltrated by carcinoma cells.

Careful examination did not reveal metastasis to the bone. The grayish areas in the lungs were made up of groups of undifferentiated epithelial cells which had a very slight tendency toward alveolar formation, filled the lymph spaces and were found in the lumina of blood vessels (fig. 3).

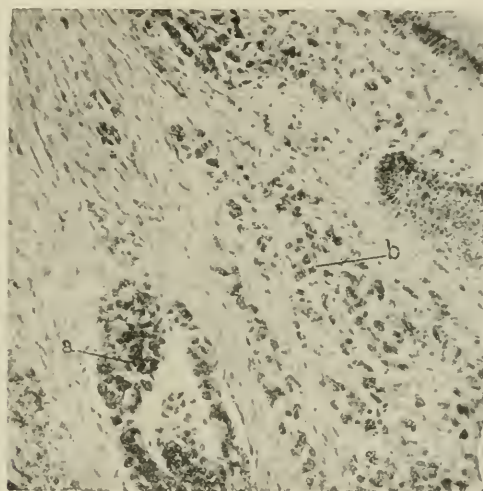


FIG. 7. *a*, SECONDARY CYTOPLASIA IN PROSTATE GLAND. *b*, TERTIARY CYTOPLASIA. $\times 100$

The infarct found in the left kidney proved, by means of serial sections, to be due to metastatic carcinoma cells plugging a small blood vessel (fig. 4). The nodules found at the ureteropelvic juncture were composed of the same type of undifferentiated epithelial cells (fig. 5).

In sections taken from various points of the prostate it was possible to trace the various degrees of proliferation to the glandular epithelium. Figure 6 illustrates the early secondary cytoplasia taking place in the inner epithelial layer, while adjacent to the gland are found malignant cells without differentiation (fig. 7).

Sections through the rough, granular area of the bladder showed it to be a direct carcinomatous infiltration.

The metastasis to the pelvis of the kidney in this case may be interpreted as illustrating the direct lymphatic connection to the prostate, bladder and kidneys and may be considered evidence that infections of the bladder reach the kidney, not by the lumen of the ureters, but by the lymphatics. However, this does not seem probable, as the lymphatics of the ureters were not involved. Moreover, so far as we know, this is the only case reported in the literature in which carcinoma of the prostate metastasized to the renal pelvis. This extreme rarity should be strong presumptive evidence that direct lymphatic connections between the lower and upper urinary tract do not exist and that infection does not travel in this manner. Otherwise, with the large number of neoplasms of the bladder and prostate, metastasis to the kidney would occur more often.

In this case, the presence of the cancer cells in the blood vessels of the lungs and the metastatic renal infarct would seem to demonstrate that the malignancy was carried through the blood stream to the ureter rather than by the lymphatics, a route probably travelled by many so-called ascending infections.

STREPTOTHRIX PROSTATITIS

PRELIMINARY REPORT

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Received for publication August 22, 1922

I. CHRONIC PROSTATITIS—PRESENT STATUS

a. Symptoms

Chronic prostatitis may exist with symptoms that are in an inverse proportion to the findings. The usual complaints are: (1) Discharge, especially noticeable in the morning and on bodily exertion. (2) Distress in the perineal region often advancing to pain radiating down the legs or up the back. (3) Nervous symptoms which may be any of the various types of neuroses that are attributable to the genital organs, including impotence.

b. Pathology

Pathologically there are generally two types, although these types may merge so that a definite differentiation can not be made: (a) catarrhal, (b) follicular and parenchymatous. In the former the gland is slightly enlarged and softened due to thickening of the walls of the acini and ducts, which are filled with epithelia, mucus and pus. In the follicular and parenchymatous type the gland is usually smaller, presenting hard, fibrous masses separating softer areas, an evidence of abscess formation, and destruction of ducts and follicles with deposits of pus and prostatic secretion. In the most troublesome chronic cases large follicular abscesses may be found that have broken down and drained.

c. Bacteriology

It has been recognized that chronic prostatitis is due to a definite bacterial invasion frequently following a gonorrheal

infection. The usual invaders are the staphylococcus, *B. coli*, streptococcus and rarely the pneumococcus although some cases are considered amicrobic. In this latter type Chetwood says, "anaerobic bacteria (fungi) should be considered, however these are only found on culture of prostatic secretion through the urethroscope" (Chetwood, Practice of Urology page 375).

d. Therapy

We shall not attempt to mention in detail the various therapeutic agencies, for there are almost as many methods of therapy as there are men practising urology. Suffice to say that massage of the prostate along with the injection of some form of silver solution is pretty generally used.

II. PRESENT STUDY

At the suggestion of Dr. Jos. Cancik, who in the recent past had done some bacteriologic study on prostatitis at the University of Prague, we attempted bacteriologic study on a series of cases of chronic prostatitis that presented themselves for treatment at our institution.

Realizing that in a large number of cases it has been difficult to demonstrate a definite etiologic factor and recognizing the resistance of many cases to therapy, the possibility of the presence of some organism not demonstrated by ordinary methods suggested itself as an etiologic factor. The result of this study was the demonstration of a streptothrix, by cultural methods, in the prostatic secretion of a high percentage of patients with chronic prostatitis. Literary references on the pathogenic *Trichomycetes* and *Trichobacteri* may be found in the last edition of Kolle-Wassermann: "Handbuch der Pathogenen Mikroorganismen," in the article written by Petruschky.

According to Petruschky's classification the *Streptothrices* and *Actinomyces*, which together represent the group *Trichomycetes*, belong to the real fungoid microorganisms, (*Hyphomycetes*).

The *Streptothrix urethritidis* was found and described by Roček (Cas. Lek. Ces., Journal of the Czeck Physicians Prague 1920. No. 18-19.)

a. Morphology

Growth appears on plates of 1.5 per cent agar with 15 per cent human blood in twelve hours as tiny round adherent colonies of grayish color, normally with a narrow hemolytic zone, composed microscopically of mycelium.

In the original culture or in the first subculture after three days incubating at 37°C. the colonies undergo a change in their appearance; they become covered with a white powdery substance, growing from the center to the periphery of the colonies. This represents the development of hyphi, forming chains of conidia. There is very marked hemolysis at this stage, extending practically through the whole plate.

The first stage (mycelium) can only be cultivated on solid or liquid media containing about 15 per cent of human blood. The transplantation into other culture-media is to be made in the second stage (conidia) by transferring the white powder, which covers the colonies.

The mycelium is composed of threads with a tendency to fragmentation.

In the urethral and prostatic secretion or in the urine this microorganism may be found in forms, resembling micrococci, diplococci, streptococci or streptobacilli, all of these forms resulting from the fragmentation of the mycelium.

Therapeutically vaccination was used by Petruschky, with very good results in the form of the so called Streptotrichine.

b. Results of bacteriologic study

At this time I wish to present a summary of our bacteriologic results. The technic of the cultivation of the organisms was that described by Roček and the cultural character and morphology of the organism conformed also to his description.

c. First series of cases number (20) twenty

1. Material was obtained by massage of the prostate having first emptied the bladder and washed the urethra with sterile normal salt solution followed by sterile water.

2. Cultures were made on human blood agar and humanized broth incubated at 37°C.

3. Of the twenty cases in which cultures were made on special media, in 13 or 65 per cent the streptothrix was demonstrated in culture, sometimes in pure culture, sometimes mixed with staphylococci.

Of the 20 cases, in 17 there was found a definite urethral discharge, among these cases were 13 cases in which the streptothrix had been demonstrated. In 9 of the 13 streptothrix cases the discharge seemed characteristic, it was more profuse than in the other cases and was distinctly mucopurulent. This type of discharge was not noted in the non-streptothrix cases.

d. Vaccine

A vaccine was made from the pure cultures of the streptothrix. It consisted of a cloudy suspension of the triturated organisms, killed by heating at 60°C. for two hours in normal salt solution.

Injections were given hypodermically beginning with a small initial dose, 0.05 cc., repeated every three or four days and gradually increasing the dose until in some cases as high as 1 cc. were given. A local reaction developed in all the cases, varying in degree from slight redness to a marked areola 10 cm. in diameter with pain and swelling lasting three or four days. In some of the cases there was a marked systemic reaction, characterized by headache, chill and moderate rise in temperature, lasting from twelve to twenty-four hours.

Total number of injections

2 cases were given	8 injections of vaccine
5 cases were given	10 injections of vaccine
3 cases were given	15 injections of vaccine
2 cases were given	20 injections of vaccine
1 case was given	22 injections of vaccine

e. Results

Out of a total of 13 cases of culturally positive streptothrix infections:

1. Seven cases were relieved from the symptom of discharge with no other treatment. These cases had from 8 to 10 injections of vaccine. Two weeks after treatment had been suspended cultures of prostatic fluid were again made and no streptothrices were found.

2. Three cases required massage of the prostate in addition to the vaccine before relief from discharge could be noted. These cases were each given 15 injections of vaccine. Cultures taken two weeks after treatment showed a growth of streptothrix in 2 cases while in one case no growth was found.

3. Two cases improved. Massage of the prostate was given along with the vaccine. Each case was given 20 injections of vaccine. Cultures taken two weeks after treatment had been suspended showed streptothrix in both cases.

4. In one case there was no improvement with massage and 22 injections of vaccine and cultures showed streptothrices after suspension of therapy.

III. CASE HISTORY

Young man single, twenty-eight years old with a negative history except a gonorrheal urethritis five years ago. At that time there were no complications and he was dismissed as cured by his physician after treatment for six weeks. About two years ago he noticed stickiness of the meatus in the morning to which he gave little notice, since he had not been exposed to infection for several months.

Five or six months subsequent to this he noticed that a drop of pus appeared at the meatus in the morning, he also noticed a sense of pressure about the perineum which he attributed to hemorrhoids. He consulted a physician who prescribed a urethral injection which for some time gave relief. Subsequently he consulted another physician who massaged his prostate twice a week for several weeks. Again he was relieved for a short time but the condition recurred.

Examination. General physical examination was negative. Prostate moderately sensitive, large and boggy.

Secretion expressed from prostate thick and muco-purulent.

Urine, first and second glass cloudy and filled with shreds.

Cultures from prostatic secretion were made on special media, after the anterior and posterior urethra were washed out with sterile normal salt solution, followed by sterile water. Within a week a pure culture of the streptothrix was demonstrated from these cultures.

Vaccine was prepared from these cultures. The patient was given a subcutaneous injection of 0.05 cc. of this vaccine. He developed a general reaction with headache and chill within 6 hours, lasting about twelve hours. A local reaction at the sight of injection developed within twenty-four hours; it consisted of an area of redness about 5 cm. in diameter with swelling and some pain, which subsided in four days. There was no change in the urethral or prostatic symptoms.

Slight local reaction developed after all subsequent injections which were given twice a week. A marked decrease in the urethral discharge was noticed after the fourth injection, that is, fourteen days after the beginning of treatment. The patient was given 10 injections in five weeks, at which time the discharge had completely stopped.

In this case no treatment other than the vaccine was used. Two weeks after treatment was suspended, prostatic secretion was again cultured and no streptothrix was found.

Patient reported recently, no recurrence of symptoms seven months after suspension of treatment.

SUMMARY

1. Streptothrix was found by cultural methods in 65 per cent of the cases.

2. Most of the cases with positive culture of the streptothrix differed clinically from the other cases in that the urethral discharge was distinctly mucopurulent.

3. Of the 10 cases presenting clinical cures, 8 were culturally negative to streptothrix two weeks after suspension of all treatment.

4. Ten or 77 per cent of all cases in which the streptothrix was demonstrated were relieved of their urethral discharge by specific vaccine therapy, only 3 of the 10 cases comprising this percentage requiring supplemental prostatic massage.

5. Cases responded to autogenous vaccine therapy rapidly or not at all. Of the 8 cases in which both a clinical and bacteriologic cure were obtained, seven received ten injections or less. The eighth case received fifteen injections.

Two cases showed clinical but not cultural cures after fifteen injections.

Three cases showed practically no change after twenty or more injections.

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PRELIMINARY NOTICE

The twentieth annual meeting of the American Urological Association will be held at Rochester, Minnesota, May 21, 22 and 23, 1923. Contributions to the scientific program will be received by the Secretary up to March 21. From the titles submitted at that time a sufficient number to fill the program will be selected by the Program Committee. The Constitution requires that applications for membership must be submitted to the Membership Committee sixty days before the annual meeting. In order to receive consideration, all applications must be properly made out, endorsed by two members, and sent to the Secretary before March 21st, accompanied by check for \$15.00. Application blanks may be secured from the Secretary. Announcement of clinics, hotel headquarters, etc. will be sent out in a later notice. H. G. HAMER, *Secretary*, 723 Hume-Mansur Building, Indianapolis, Ind.

BRANCH SOCIETIES OF THE AMERICAN UROLOGICAL ASSOCIATION

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President—Dr. JOHN H. CUNNINGHAM, 46 Gloucester Street, Boston, Mass.
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Two meetings are each year, in April and November, occasionally a third in January. Election of officers occurs at the November meeting.

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President—Dr. FREDERICK W. SMITH, 40 E. 41st Street, New York, N. Y.
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Meetings are held the fourth Wednesday of September, November, January, and April. Election of officers is held at the March meeting.

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President—Dr. W. H. MCKINNEY, 1831 Chestnut Street, Philadelphia, Pa.
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Eight meetings are held each year, the fourth Monday of each month except during June, July, August and September. Election of officers occurs at the December meeting.

CHICAGO BRANCH

President—Dr. CHARLES H. MCKENNA, 25 E. Washington Street, Chicago, Ill.
Secretary-Treasurer—Dr. ALVIN THOMPSON, 104 S. Michigan Avenue, Chicago, Ill.

Five meetings are held each year, the last Thursday of alternating months, beginning with September and ending with May. Election of officers in May.

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Secretary—Dr. GEORGE W. HARTMAN, 999 Sutter Building, San Francisco, Calif.

Usually hold one meeting each year. Next meeting at San Francisco. Date not decided.

ABNORMALITIES OF THE KIDNEY AND URETER¹

A CASE OF DOUBLE KIDNEY AND DOUBLE URETER WITH A REVIEW OF THE LITERATURE

CHARLES M. HARPSTER IN ASSOCIATION WITH T. H. BROWN, AND
H. A. DELCHER

From the Genito-Urinary Department, St. Vincent's Hospital, Toledo, Ohio

Received for publication, August 23, 1922

Although anomalies of the kidney and ureter were known to ancient medical writers, they have always been treated rather as anatomical curiosities. It is only recently, since the introduction of systematic diagnostic procedures connected with the kidney and its adnexa, that such anomalies as double ureter and double kidney pelvis can be accurately determined in the living subject.

The following case came recently to our notice, referred to the Genito-Urinary Department of St. Vincent's Hospital by Drs. R. L. Bidwell and A. E. Cone.

CASE REPORT

Miss K., forty years; white; entered hospital, September 29, 1921.

Personal antecedents. Usual children's diseases: scarlet fever and diphtheria; tonsillitis.

In 1912 appendix and both ovaries removed.

Family antecedents. Nothing of interest bearing on case.

Present illness. Began September 24 with pain in upper right abdominal quadrant and back; steady non-radiating pain; occasional nausea and vomiting; pain more acute after eating; no disturbance of micturition.

State on examination. Urinalysis: color dark; specific gravity 1.013, acid reaction; negative for albumen and sugar; some epithelial and pus cells with debris. Nothing abnormal was observed in the thorax. The

¹ Read before the American Urological Association, Atlantic City April, 1922.

spinal column showed some marked kyphosis and scoliosis. In the abdomen there was dull pain on pressure over the lower border of ribs on right side and marked pain in the corresponding region in the back.

Roentgenogram after cystoscopy shows a shadow of calculus in right kidney. The catheter goes to the kidney on this side. The left kidney shows two distinct ureters and two kidney pelvis in a kidney shadow about twice the size of normal. The right kidney shadow is normal.

The left side was injected with sodium bromide and showed bifurcation of the left ureter about two inches above the ureteral orifice in the bladder. From the X-ray findings a diagnosis of double ureter and double pelvis was made.

The X-ray pictures were made by Dr. John Murphy at St. Vincent's Hospital. Figure 1 shows ureter injected with sodium bromide with the double ureter and double pelvis clearly distinguished as well as the bifurcation about two inches above the orifice in the bladder. Figure 2 shows X-ray catheter in a ureter (there is a small calculus in the kidney).

It is now generally admitted that the occurrence of double ureter, either complete or incomplete is not an infrequent event. Poirier (1), Bostroem (2), Huntington (3), Papin (4), and Motzfeld (5), and others have variously estimated the anomaly as occurring in from one to four and even a higher percent in all individuals. Although there is much discrepancy among the figures given by different investigators still the facts are sufficient to show that the condition is one which any urologist is liable to meet. The presence of a double ureter is a disturbing element in the clinical picture of kidney disease and likely to lead to diagnostic errors. From the surgical point of view it is not only manifest that an unsuspected duplicate ureter may lead to untoward complications; but also, looked at from another angle, in a pathologic kidney when such a condition is known, the fused or double kidney, which usually accompanies the double ureter, permits of conservative surgery which is not possible with a single normally developed organ.

Duplication of the ureter is usually accompanied by double or fused kidney, and as a consequence by duplication of the kidney pelvis. In a few cases in literature the two kidneys on the same side are quite distinct, the third kidney being in fact

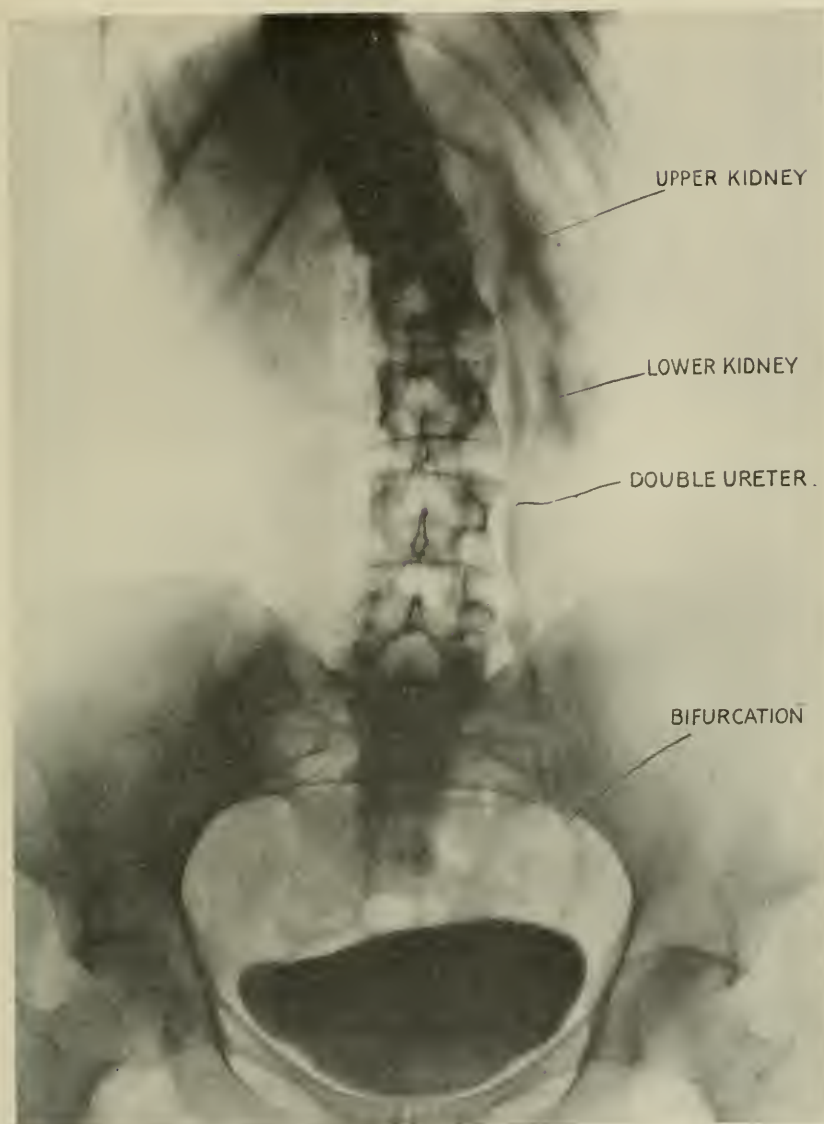


FIG. 1

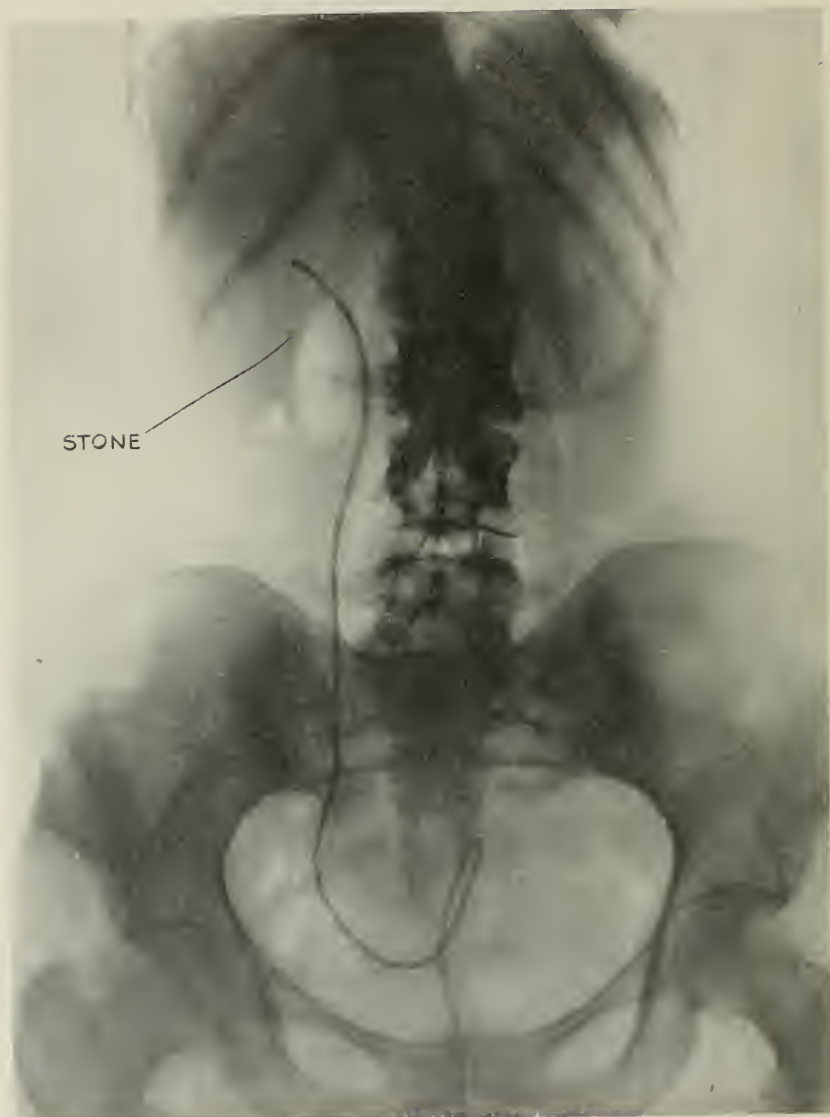


FIG. 2. CATHETER IN URETER—STONE LOWER POLE OF KIDNEY

supernumerary and ectopic. From this condition all grades of double kidney exist down to that in which the kidney is composed of two parts which are only separated by some connective tissue. The existence or the degree of completeness of kidney duplication accompanying a double ureter is not always stated in reports in the literature; nor even has the existence of duplicated pelvis been always demonstrated or reported. Even when the ureteral duplication is incomplete such duplication of the kidney including the pelvis may be surmised. Braasch (6) in a number of cases found that there was always a double pelvis and he says that for all practical purposes the kidney may be considered as double. Bruci (7) thinks it plausible to admit that duplicity of ureters is a frequent index of renal duplicity more or less manifest. Considering (a) that the kidney blood supply is usually distinct in the upper or lower parts; (b) that the two parts of the kidney are separated by a band of strangulated kidney or fibrous tissue; and (c) that there are separate pelves. Bruci concludes that these are really cases of double or fused kidney. Papin (4) who made a very thorough study of the condition remarks that while some authors have reported two ureters coming from one pelvis he has never observed such a condition in any specimen seen by him nor has he found it substantiated by the more detailed reports in the literature. He is quite satisfied that even in cases of unilateral bifid ureter the pelvis is always doubled. This is contrary to the opinion of Schwarz (8) who from reports of 68 collected cases states there was only one pelvis in the majority. Delmas (9), however, in 251 cases of ureteral anomalies (including duplicity) most frequently found two distinct pelves accompanying duplicated ureter.

The two pelves are generally placed one above the other. Papin (4) states that one is never in front of the other. Generally the lower pelvis is larger than the upper. It is exceptional that the two ureters drain equal portions of the kidney. The form of the kidney is usually normal and from external inspection alone there may be little reason to suspect ureteral duplication, unless there is a distinct band which separates the parts

of the duplex kidney. On the duplicated side the fused kidney may be larger than its congener.

The two ureters from a fused kidney may run a distinct course ending each by its own distinct orifice in the bladder, or or one ureter may end normally in the bladder and the other may end in some other part of the genito-urinary tract. In the male such abnormal discharge may be in the prostatic urethra, in the ejaculatory duct or seminal vesicles. In the female the discharge may be in the urethra or vulva. Occasionally the two ureters may run side by side, enclosed in a common sheath, to the bladder. The normal ureter on the duplicated side usually discharges in the normal orifice in the bladder.

The duplex ureters may, however, join together and enter the bladder by a single orifice. This bifurcation may take place close to the hilum of the kidney; but its more frequent situation is within 3 to 5 cm. from the bladder. In a number of cases Papin (4) found that there was high bifurcation in thirteen, medium in sixteen, and low in twenty-two. Unilateral bifid ureter of this kind is the most frequently observed anomaly. It is more usually found on the left side. Although there is apparent bifurcation it is sometimes found that the two ureters continue their course separately to the bladder wall enclosed within a single sheath. When the two are thus enclosed the ureter coming from the upper part of the kidney is usually posterior to the other though it may pass to the anterior position before they enter the bladder.

When there are separate orifices in the bladder Sacquefee (10) says that in some cases they are neighbors and situated in the normal position at the posterior angle of Lieutand's triangle; but frequently one orifice is normal and the other more or less distant discharging abnormally in the bladder or outside the bladder.

We are now in a position to classify the various types of duplicated ureter. If the duplication occurs on both sides, it is bilateral and may be complete or incomplete according as there are four, or only two or three distinct ureteral discharge orifices. Moreover, the kidney may be distinctly supernumer-

ary or of the fused or double kidney type. It is assumed that in all cases the pelvis is duplex. If the duplication is on one side only then it is unilateral and may be complete or incomplete according as each of the duplex ureters has a distinct discharge orifice or join together to discharge by one orifice. As before, duplication of the pelvis and kidney are assumed. In a few such cases there is also a distinct supernumerary kidney.

An exhaustive search through the literature has shown that a large number of the different types of anomalies have been reported. These have been classified and are arranged in the tables which accompany this report. Of complete bilateral duplication there were forty cases.

There are twenty-eight cases of incomplete bilateral duplication. This table includes cases where there is complete duplicity on one side accompanied by incomplete duplicity on the other.

There are 181 cases of complete unilateral duplication and 133 cases of incomplete unilateral duplication which latter table includes our case.

It is very possible that incomplete unilateral duplication occurs much more frequently than is reported. We have been compelled to omit a few probable cases either because we could not get access to the original report or because it was of such a meagre nature that it could not be classed. Altogether 382 cases of complete or incomplete ureteral duplication have been collected in these tables which is by far the largest and most complete collection of this anomaly reported in medical literature up to the present time. Great care has been taken to classify the cases under the respective headings where placed.

It may be remarked that bifurcation of the lower extremity of a single ureter with two bladder orifices has been reported. Papin (4) does not admit the possibility of such an anomaly especially on embryological grounds. It is probably a case where the two ureters in their upper part continued separately under a common sheath. It has not been verified by anatomical findings.

The cases where a supernumerary ureter opened in an abnormal situation in the bladder, or extravasically are distin-

TABLE 1
Complete bilateral duplication (pelvis, ureter and urinary outlet) with fused or double kidney in varying degree

REPORTER	REFERENCE	NUMBER OF CASES	AGE AND SEX	REMARKS
Rayer Petrequain	"Maladies de rein," 1837 Gaz. med. de Par., 1837, v, 1957	1	—	1 case; also quoted by Schwarz
Juettinig	Dissert. Berl., 1838, Pt. 2. p. 21	1	—	This patient has also a double bladder
Lionville and Coeyne	Bull. Soc. anat. de Par., 1868, xii, 55	1	—	Autopsy
De Font, Reaulx	Bull. Soc. Anat. Paris, 1865, x, 645	1	—	
Bachhammer	Arch. d. Anat. u. Physiol., 1879, p. 139	2	—	Two cases of complete bilateral duplica- tion
Tangl	Virch. Arch. 118, 414	1	—	One supernumerary ureter opened in pros- tatic urethra
Ewart	Trans. Path. Soc. of Lond., 1880, xxxi, p. 188	1	M 45	Autopsy
Catell	Path. Soc. Phil., 1891-3, xvi, 206	1	—	
Debierre	Soc. anat., 1894, 630	1	F, infant	
Morestin	Bull. Soc. anat. Par., 1894, lxix, 630	1	F	Autopsy
Jacques	Presse med. Par. 1897, supp. p. clxiii	1	F	Autopsy. One ureter opened abnormally in bladder
Meslay and Veau	Bull. Soc. Anat. Par. 1896, 71, 208	1	Boy	Autopsy. 2 supernumerary ureters opened in prostatic urethra
Janeway	Med. Record. N. Y., 1902, lxi, 514	1	F, middle aged	Autopsy

Gould	Amer. Jour. Med. Sc., 1903, exxv, 428	2	Child and F, 50	2 cases. Both autopsy findings. 4 bladder orifices in each case
Echeverra	Semana Med., 1903, x, 1113.	1	—	
Hamburger	Protok. zasaid. Karkazst. Tiflis., 1903-4, xl, 206	1	—	
Decherd	Amer. Jour. Med. Sc., 1904, exxvii, 104	1	M, adult	Autopsy
Unterberg	Budapesti ujsag., 1911, ix, 795	1	—	
Commolli	Monit. zool. ital., 1911, xxii, 113	1	Infant	
Seelig	Zeitr. f. urol. 1911, v, 920	1	F, 44	
Braasch	Ann. Surg. 1913, lvi, 726.	1	—	
Rendu	Lyon. med. 1911	1	F, 35	Autopsy
Alsberg	Cited by Hartmann. Zeit. f. urol. 1913, vii, 429	1	F, 18	One supernumerary ureter discharged in vaginal wall
Madelung	Cited by Hartmann. Zeit. f. urol., 1913, vii, 429		—	One supernumerary ureter opened in vagina
Rumpel	Zeitsch: f. urol. Chir., 1914, ii, 33.	2	M, 46	In both cases there were four functioning orifices in the bladder. The upper half of left kidney which in both cases was hydronephrotic was resected. Both patients recovered. Diagnosed cystoscopically
Ridd	Urol. & Cut. Rev. Tech. Supp. ii, 1914, p. 24	1	M, 51	Demonstrated by cystoscopy and pyelography
Furniss	Amer. J. obst., 1915, 71, 669	1	—	Case 3
Peacock	Jour. Amer. Med. Ass'n., 1916, lxxvi, 1088	1	M, 9 months	Autopsy
Reid	Jour. Anat., 1916, lxxi, 30	1	M	Autopsy

TABLE 1—*concluded*

REPORTER	REFERENCE	NUMBER OF CASES	AGE AND SEX	REMARKS
Hopburn Pavlov	Ann. Surg., 1918, lxxvii, 294 Deut. Zeitsch. f. Chir. cxxi, 425	1	F, 45 F, 35	1 case Autopsy
Pineyro Carve	Anal de la Fac. de Med. Montevideo., 1920, v, 100	1	M, 37	Hydronephrosis in each lower pelvis. Diagnosis verified by pyelography
Neil Moore	Urol. & Cutan. Rev. Feb., 1921, xxv, p. 69	1	M, 34	Discovered during cystoscopy and veri- fied by pyelograms. Not operated
Simon	Urol. & Cutan. Rev., 1918, xxii, 528	1	M, 20	Diagnosed by cystoscopy and pyelog- raphy
Mertz	Urol. & Cutan. Rev., Nov. 1920, xxiv, 636 and Urol. & Cutan. Rev., 1918, xxii, 553.	3	—	Either personally observed or collected unpublished cases
Total number of cases		40		

guished in the tables, as far as reported. Most of the cases now reported were autopsy findings; but a fair number were discovered during operation. Only a few have been diagnosed preoperatively. The cases of Stark, Seelig, Klose, Unterberg, Nemenov, Herrick, Young and Davis, Gottfried, Thumin, Simon and Mertz, Wossidlo, Lewis, Kakouchine, Voelker, some of the cases reported by Mertz and our own were diagnosed. When there are distinct bladder orifices the diagnosis is of course at once suggested; but where there are only two orifices in the bladder and pathological conditions which cannot be satisfactorily accounted for, and cystoscopy and separate deviation of urine fails to give a clue, the more modern diagnostic methods of pyelography and X-ray examination will often bring such a condition to light. The fact of the establishment of the great relative frequency of double ureter and its more frequent diagnosis in recent years since the introduction of pyelography should put every urologist on his guard and pyelograms should be made as a matter of routine in any condition where there is the least reason for suspicion.

It is a general law that an abnormal organ is more susceptible to pathological conditions than a normal organ. A very large proportion of double kidneys and ureters will therefore be found diseased. The point has already been discussed by Botez (11) who by a statistical study demonstrated that malformation predisposes to disease. In 51,504 autopsy records Botez found the frequency of horseshoe kidney to be one in 715 while in a series of one thousand kidney operations the proportion was one in 143, i.e., five times as great. Botez concluded from this that a horseshoe kidney is more liable to become diseased than a normal one. In double kidney and double ureter hydronephrosis and pyenephrosis is quite common but many have not been diagnosed or operated. Young and Davis (12) recently found in literature reports of such a lesion in 25 of 29 cases in which some surgical operation was done for double kidney, twenty-one of these operations were nephrectomies. In their own case (which was correctly diagnosed preoperatively) they did a successful resection of the diseased portion of the double kidney occupied by a large calculus.

TABLE 2
Incomplete bilateral duplication

REPORTER	REFERENCE	NUMBER OF CASES	AGE AND SEX	REMARKS
Dowling Wood	Lancet, Lond. 1832, i, 733 Trans. Path. Soc. of London, 1855-6, vii, 261	1 1	F, 22 F, 10	Complete on right; bifurcated on left. The left ureter was doubled, but only one pelvis. On the right there were 2 ureters and 2 pelvis; one ureter discharged into the bladder—the other into urethra
Geerdts	Dissert. Riel, 1887	1	—	Each kidney had two separate pelvis and ureters. On the left side the two ureters joined about 10 cm. after leaving pelvis; on the right the two ureters had separate orifices in bladder
Davidson	Liverpool Med. & Chir. J., 1888, p. 258	1	F, 55	Both double ureters bifurcated.
Dahlerup	Bibliof. f. Laeger. 5 R, xvi, H. 2	1	—	2 ureters on the right united shortly before entering the bladder. The two ureters on left had independent meati in the bladder
Bitdrell	Trans. Path. Soc. of London, 1890, xli, 171	1	M, child	The 2 ureters on left discharged by separate orifices in bladder; the 2 ureters on right side discharged by one orifice in bladder
Conitzer	Zentralbl. f. Gynack, 1895, p. 266	1	—	Complete on right; on left one ureter opened into vagina
Jolly	Bull. Soc. anat. de Par., 1896, lxxi, 9	1	F, 24	The 2 ureters on the left had independent orifices in the bladder. The 2 ureters on right joined 13 cm. below pelvis

Sacquepee	Jour. de l'anat. 1900, xxxvi, 103	1	—	Autopsy. There was complete duplication on the right side; on the left 2 pelves and 2 ureters which joined and discharged through one orifice in bladder
Laurens	Echo med. Paris, 1901, v, 109	1	—	
Levison	Jour. Amer. Med. Ass'n. 1904, xlii, 1354	1	M, 65	Autopsy. Double pelves and ureters on both sides. The two ureters on each side joined before entering the bladder
Harbinson	Brit. Med. Jour. 1904, 1, 488	1	F, 60	Autopsy. 2 ureters on each side with separate pelves. On left side the two ureters opened separately into the bladder. On the right the ureters joined about 3 cm. before entering bladder
Reinfelder	Disset, Muenchen., 1905	1		Right supernumerary ureter ended in bladder left incomplete. Autopsy
Uteau	Bull. Soc. anat. de Paris, 1905, lxxx, 34	1	—	Autopsy finding
Kapsammer	"Nierenchirurgie," 1905	1	—	Case 157. 4 ureteral orifices in the bladder with union of the two ureters on right side at about 13 cm. above meati; on the left both ureters had separate pelves
Jourkovskaia	Russk Vrach., 1909, vii, 1014	1	F, 9	Autopsy. Each kidney had 2 ureters and 2 pelves. 2 ureters discharged normally in bladder. The two upper ureters ended in blind sacs in bladder wall
Robinson	Pediatrics, 1909, xvi, 605	1	—	Incomplete bilateral duplicity

TABLE 2—*concluded*

REPORTER	REFERENCE	NUMBER OF CASES	AGE AND SEX	REMARKS
Handl	Frankf. Zeitsch. f. Pathol., 1910, v, 142	1	M, 29	Autopsy. Both kidney pelves and ureters duplicated; on the right one ureter discharged into colliculus seminalis. On the left the 2 ureters joined about 2 cm. before entering bladder
Braasch	Ann. of Surg. 1912, lvi, 726	1	—	On each side the 2 ureters joined in the muscular coat of the bladder and entered by one orifice
Duron	Poitou med., 1912, xxvii, 73	1	M, 16	Ureter on each side duplicated. The supernumerary ureter at each side discharged into urethra. Diagnosed by cystoscope and pyelograms. Each kidney had only one pelvis
Stammeler	Zeitschr. f. urol. chir., 1913-4, ii, 241	1	F, 15	There were 2 bladder orifices on left side; on the right side the 2 ureters ended in an ampulla in bladder wall
Wakely	Jour. Anat. & Physiol., 1914-15, xlix, 148	1	M, 68	Found during gynecological examination. 4 orifices in the bladder double pelves were not demonstrated
Worral	Jour. Obst. & Gynec. of Brit. Empire, 1914, xxvi, 159	1	F, 46	Double pelves not demonstrated
Bugbee and Losse	Surg. Gynec. & Obst., 1919, xxviii, 97. Cases 19, 21, and 22	3	F, 32 F, 36 M, 24	
	Surg. Gynec. & Obst., 1919, xxviii, 6. Cases 19, 21, and 22	1	M, 60	On the right double pelves and double ureter. Incomplete duplication of left pelves. 2 orifices in bladder
Bugbee	Surg. Gynec. & Obst., 1919, xxviii, 97 Case 10.	1	F, 24	Pelves on both sides duplicated
Total number of cases		28		

TABLE 3
Complete unilateral duplication with distinct supernumerary kidney.

REPORTER	REFERENCE	NUM- BER OF CASES	SIDE	AGE AND SEX	REMARKS
Hyrtil	Quoted by Girard	1	Left	F, old	The supernumerary kidney was situated toward sacro-iliac symphysis
Newman	Trans. Clin. Soc. Lond., 1898, xxxi, 131	1	Left	M, adult	Autopsy finding
Watson-Cheyne	Lancet. Lond., 1899, 1, 218	1	Right	F, 22	Clinical finding
Bartlett	Lancet. Lond. 1904, 1, 124	1	Left	Not stated	Autopsy finding
Munro and Goddard	Amer. Jour. Med. Sc., 1907, 398	1	Left	M, 23	Clinical finding
Gobb and Giddings	Ann. Surg. 1911, liii, 367	1	Left	M, 67	Clinical finding
Wedensky	Folia urol., 1911, vi, 345	1	Right	M, 28	The ureter from the supernumerary kidney ended in the prostatic urethra. Autopsy finding
Mills	Jour. Anat. & Physiol., 1911-12, xlvii, 313	1	Left	M, adult	
Isreal	Berl. Klin. Wehnschr., 1918, iv, 1081	1	Left	F, 32	3 fully separate kidneys. The supernumerary kidney ureter discharged in the genital apparatus. Found on operation
Gottfried	Zeitschr. f. urol. Chir., 1920, vii, 1920	1	Left	F, 29	The accessory kidney lay under the inferior pole of the left kidney. 3 orifices in the bladder. Diagnosed by pycelography
Total number of cases.....		10			

TABLE 4
Unilateral complete duplication with fused kidney

REPORTER	REFERENCE	NUM- BER OF CASES	SIDE	AGE AND SEX	REMARKS
Marcorelli	Acad. roy. d. sc., Paris, 1774, p. 611	1	Right	—	
Cusco	Bull. Soc. anat. de Paris, 1841, xxi, 51	1	Left	—	
Broca	Bull. Soc. anat. de Paris, 1850, xxv, 165	1	Left	—	
Pilate	Bull. Soc. anat. de Paris, 1867, xlii, 366	1	Not stated	M	
Morgagni	Cited by Schwarz. Beitr. z. klin. Chir., 1895, xv, 159	2	—	—	
Gusserow	Cited by Schwarz. Beitr. z. klin. Chir., 1895, xv, 159	1	Right	F	
Furst	Arch. f. Gynack., x, 161	1	Right	—	Observed in 2 years. In some of these the remaining ureter was in- completely duplicated
Weigert	Virch. Arch., lxx	12	—	—	
Lemarchand	Bull. Soc. d'anat., Paris, 1861, xxxvi, 113	1	Left	—	
Rayer	Quoted by Schwarz, Beitr. z. klin. Chir., 1895, xv, 159	2	—	—	Each with 3 ureteral orifices in blad- der
Bornhaupt	Petersb. med. Wchnschr., 1879, No. 45	1	Right	—	

Bachhammer	Arch. f. Anat. u. Physiol., 1879, p. 139	1	Left	—	—	Autopsy	Supernumerary ureter opened into urethra
Gangolphe	Lyon med., 1883, xliii, 282	1	Left	—	—	Autopsy.	Supernumerary ureter
Dickenson	Trans. Path. Soc. of Lond., 1893, xlv, 126	1	Left	—	M, 57		
Halasy	Anat. Anzeiger, 1893-4 ix, 631.	1	Left	—	M		
Adami and Day	Montreal Med. J., 1894	2	Left	—	M, 65 F, adult F, 29		
Davenport	Liverpool Med. Chir. Jour., 1888, p. 258	1	—	—	—		Ectopic ureter discharged near urinary meatus
Ardin-Deiteil	N. Montp. med., 1894 iii, 389	1	Left	—	—		
Griffon	Bull. Soc. d. anat., Paris, 1894, lxix, 627 id., 1896, lxxi, 251	2	Left	—	M, 60 F, 14		
Wrany	Cited by Schwarz. Beitr. z. klin. Chir., 1895, xv, lxxi, 159	2	—	—	M		Supernumerary ureter opening abnormally in bladder wall
Cases of Civile, Weigert, Bostroem, Remy, Zalusky	Cited by Schwarz. Beitr. z. klin. Chir., 1895, xv, 159	5	—	—	—		Cases of supernumerary ureter opening into urethra
Cases of Hoffman, Rediquet, Palma	Cited by Schwarz. Beitr. z. klin. Chir., 1895, xv, 159	4	—	—	M		Cases of supernumerary ureter opening in seminal vesicle, ductus ejac. or vas deferens
Cases of Erlach, Kollisko, Tauffer	Cited by Schwarz. Beitr. z. klin. Chir., 1895, xv, 159	3	—	—	F		Supernumerary ureter opening in urethra
Cases of Josso, Baum	Cited by Schwarz. Beitr. z. klin. Chir., 1895, xv, 159	2	—	—	F		Supernumerary ureter opening in vestibule vaginae

TABLE 4—continued

REPORTER	REFERENCE	NUM- BER OF CASES	SIDE	AGE AND SEX	REMARKS
Cases of Lechler, Lilienfeld, Oster- loh, Stolz, Heller, Geerds, Ortmann	Cited by Schwarz, Beitr. z. klin. Chir., 1895, xv, 159	7	4, left 3, right	1-M 6-F	Supernumerary ureter ending in a blind sac extra vesically
Cases of Olshausen, Benckiser, Ser- theim, Holmeier, Josephson, Chris- tofolielli, Kuettnr, Hartmann.	Cited by Hartmann Zeit- schr. f. Urol., 1913, vii, 429	8	3, right 1, left 4, side not stated	—	Unilateral supernumerary ureter dis- charging extra vesically
Soulie	Comp. rend. Soc. de biol., Paris, 1895, cv (ii) 422	1	Left	fetus	
Auscher	Bull. Soc. d'anat., Paris, 1895, lxx, 748		Left	—	
Ramsay	Johns Hopk. Hosp. Bull., 1896, vii, 201	1	Left	F, 45	Autopsy
Obici	Bull. d. sc. med., Bologna, 1896, vii, 405	1	Right	M, 50	Autopsy. Both ureters on right side opened into prostatic urethra
Fullerton	Amer. Gynec. & Obst., 1897, xi, 656	1	Right	F, 36	Found on operation
Albarran	Gaz. d. hop. Paris, 1897, lxx, 743	1	—	F, 20	Supernumerary ureter opening into vagina and vulva
Cathelin	Bull. Soc. anat. Paris, 1898, lxxiii, 596	1	Right	F, 21	Autopsy
Wigglesworth	Liverpool med.-chir., J., 1899, xix, 403	1	Right	—	Autopsy

Albarran and Cottet	Bull. Soc. anat. Paris, 1898, p. 40	1	Left	F, 42	Autopsy
Thummin	Monatsb. d. Harn-Urank., 1900, v, 582	1	Right	F, 32	Cystoscopic, photograph, diagnosis
Cognard	Lyon med., 1901, xevii, 695	1	Left	—	Autopsy
Summers	Ann. Surg., 1901, xxxiii, 39	1	Left	F, child 2½ years	Nephrectomy
Tschudy	Corr. Bl. f. Schweiz. Aerzte, 1902, xxxii, 400	1	Left	F, 25	Pyelonephrotic
Elliesen	Beitr. z. klin. chir., 1902, xxxvi, 644	1	Right	M, 26	Autopsy. Supernumerary ureter ended in cyst in bladder wall
Fenwick	Handbook of Clinical iii, 181	1	Left	—	
	Electric., 1904, ch. xix, p. 364	1	Left	F, 30	
Klose	Deutsche Zeitsch. f. Chir., 1904, lxxii, 613	1	Right	F, 59	Diagnosed by cystoscope and radiograms; verified on operation
Linck	Deutsche Ztschr. f. Chir., 1904, lxxv	1	Right	F, 8	Supernumerary ureter ended in vagina
Nicolich	Ass'n. franc. d. urol., 1905, ix, 580	1	Right	M, 40	Supernumerary ureter opened in urethra
Cristalli	Med. ital., Naples, 1905	1	Left	—	Supernumerary ureter opened in prostatic urethra. Mentioned in discussion on paper by Nicolich.
Albarran	Assn. fr. d'urol., 1905, ix 580	1	—	M, 26	Double kidney partly resected
Kapsammer	Nierenchirurgie, 1905, ii	1	Left	M, 65	

TABLE 4—continued

REPORTER	REFERENCE	NUM- BER OF CASES	SIDE	AGE AND SEX	REMARKS
Lewis	Med. Record, N. Y., 1906, lxx, 521	1	Left	M, 24	Three openings in bladder. Cysto- scopic diagnosis
Voelker	Diag. d. Chir. Nieren- krankh., 1906, p. 14.	1	Left	—	Diagnosed by pyelograph and cysto- scope
Pruneau	Bull. Soc. Cent. de med. veterin., 1907, lxi, 296.	1	Left	F	
Chute	Bost. M. & S. J., 1907 clvii, 385	1	Left	M, 42	Operative finding supernumerary ureter opened in prostatic urethra
Marion	Bull. Soc. de Chir., Paris, 1908, xxiv, 905	1	Right	F, 41	Operation
Francke	Beitr. z. klin. Chir., 1909, lxiv, 193	1	Left	—	
Wille	Forhand. Krist. Kirurg., 1909, p. 14	1	Left	F, 19	Double kidney: one part hydroneph- rotic. Nephrectomy.
Robinson	Pediatrics, 1909, xvi, 605	9	6, left 3, right		Observed during a course of years, in dissections, etc.
Sergi	Revist. urolog., 1910, i, 665.	1	Left	—	
Kerr	Anat. Record., 1911, v. 55.	5	3, right 2, left	4-M 1-F	These cases were found in the exam- ination of 165 cadavers (120 males, 45 females). All complete uni- lateral cases
Bruci	Ann. d. mal. gen. urin., 1911, xxix, 961.	1	Right	F, 22	Operated case
Nenemoff	Chirurg. Arch. Veliam, 1911, xxvii, 1401.	2	Left	—	In one case the supernumerary ureter discharged into urethra

Young	Trans. Am. Urol. Assn., 1912, vi, 161	1	Left	M, 32	Tuberculous double kidney
Key	Zeitschr. f. urol., 1912, iii, 409	1	Right	F, 18	
Kakouchkind	Russk. Vrach., 1912, xi, 147	1	Right	F, 32	Diagnosed radiographically. Verified on operation. Supernumerary ureter opened into urethra near meatus
Braasch	Ann. Surg., 1912, lvi, 726	7	—	—	All kidneys practically double 7 unilaterally complete cases found during 5 years in 176 cases examined at the Mayo clinic
Keymann	Zeitsch. f. urol., 1912, vi, 473	1	Left	F, 21	Diagnosed before operation. Verified on operation. Tuberculous kidney (double)
Ehrenpreis Dubrotworski	Presse med., 1913, xxi, 99 Zeitsch. f. urol., 1913, vii, 93	1 1	Right Right	— M, 38	Double kidney. One part of the tuberculous and isolated
Juvara	Bull. Soc. de Chir., Paris, 1913	1	Right	F	Supernumerary ureter discharged in vulva
Suter	Fol. urol., 1913, viii, 35	1	Right	M, 23	Operation finding
Kalenitschenko	Zeitsch. f. urol., 1913, vii, 581	2	1, right 1, left	— —	
Lockyear	Proc. Roy. Soc. Med., Lond., 1914-15, Sect. Obst. & Gynec., viii, 47	1	Right	F, 63	Dilated ureter simulated an ovarian cyst
Duhot and Cordier	Echo. med. du nord, 1914, xviii, 4	1	Left	M, 55	Autopsy
Fromme	Zeitsch. f. Gynaek. u. Geburts., 1914, lxxv, 758	1	Left	F	Supernumerary ureter discharged in urethra

TABLE 4—concluded

REPORTER	REFERENCE	NUM- BER OF CASES	SIDE	AGE AND SEX	REMARKS
Furniss	Amer. Jour. Obstet., 1915, lxxi, 669	13	9, right 4, left	—	In discussion Bandler said he had observed 5 similar cases with three openings in the bladder. Tovey saw 1 case
Ries	Am. Gynecological Soc. Trans. 1890, xv, 343	1	Left	F, 19	Supernumerary ureter ended near vulva
Lossee	Amer. J. of Obst., 1915, lxxi, 672	1	Right	Fetus	3 orifices in bladder
Simon and Mertz	Jour. Amer. Med. Assn., 1916, lxvi, 1686	1	Right	F, 26	Demonstrated by ureteropyelography
Gelsinger	Ann. Surg., 1917, lxxv, 355	4	2, right 2, left	F, 3 M, 1 adult	Complete unilateral
Pileher	Ann. Surg., Phils., 1917, lxv, 584	1	Right	M, 41	Calculus in one distinct sac of right kidney. Operative finding
Wossidlo	Zeitschr. f. urol., 1920, xiv, 194	1	Left	—	Demonstrated by pyelogram and cysto- scope
Carve	Anal. de la Fac. de Med. Montevideo, 1920, v, 100	2	1, left 1, right	M, 21 M, 26	Found in course of 200 nephrectomies
Pavlov	Deut. Zeitsch. f. Chir., exxi, 425	5	1, left 4, right	3, M 2, F	Lower part of double kidney success- fully resected for hydronephrosis.
Herrick	Surg., Gynec. & Obst., 1920, xxx, 560	1	Right	F-18	Either personal or collected unpub- lished cases
Mertz	Urolog. and Cutan. Rev. 1918, xxii, 553	9	—	—	One ureter ended in blind sac
Guibal	Jour. d'urol. 1921, xi, 307	1	Right	F-35	
Total number of cases.....		171			

TABLE 5
Incomplete unilateral duplication with distinct supernumerary kidney.

REPORTER	REFERENCE	NUM- BER OF CASES	SIDE	AGE AND SEX	REMARKS
Case	Reported in U. S. Marine Hosp. Reports, 1885	1	Left	—	There were only 2 orifices in the bladder. Autopsy
Depage	Jour. de med. et chir. Bruxelles, No. 11, 1893	1	Left	F, 20	Clinical finding: was diagnosed as a tuberculous mesenteric gland. Nothing stated as regards number of bladder orifices.
Hansenann	Berl. Klin. Wehnschr. 1897, p. 81	1	Left	M, 57	Autopsy. Only 2 orifices in the bladder
Rustschinski	Wratsch. Gaz. 1907, No. 22	1	Left	M, adult	Autopsy finding. All 3 kidneys diseased. Only 2 orifices in the bladder
Calabrese	Ann. d. mal. d. org. gen. urin. 1908, ii, 1841	1	Left	F, 55	Clinical finding. Only 2 orifices in bladder
Gavard	Cited by J. & P. Delmas Ann. d. mal. d. org. gen. urin. 1910, xxviii, 777	1	Right	M, 40	A third supernumerary kidney em- bedded transversely in front of spinal column. Its ureter joined with that from the normal right kidney in its lower third. 2 blad- der orifices
Isaya	Ann. d. mal. d. org. gen. urin. 1911, 225	1	Right	F, 27	Only 2 orifices in the bladder. Clin- ical findings
Tonkou	Cited by Wedensky, Folia urol. 1911, vi, 345	1	Right	—	Only 2 orifices in the bladder. Autopsy finding
Kretschmeyer	Jour. Amer. Med. Ass'n. 1915, lxx, 1447	1	Left	F, 27	Only 2 orifices in bladder. Calculi in 2 kidneys. Clinical findings
Total number of cases.....		9			

TABLE 6
Incomplete unilateral duplication

REPORTER	REFERENCE	NUM- BER OF CASES	SIDE	AGE AND SEX	REMARKS
Lediberdee	Bull. Soc. anat. Paris, 1834, ix, 187	1	—	—	In both cases 2 pelves. The 2 ureters united before entering bladder, in 1 case at 10 cms. from bladder. Incomplete bifurcated unilateral. Some had distinct pelves
Allen	Phila. Med. Times, 1873-4, iv, 220	1	—	—	
Spaletta	Bull. Soc. anat. Paris, 1895, lxx, 616	2	1, left 1, right	F	
	Cited by Schwarz. Beitr. zur. Klin. Chir. 1895, xv, 159	8	—	F	
Cases of Koch, Roberts, Niemayer, Furstner, Bert, Weigert, Neelsen, and Bachhammer	Berl. Klin. Wchnschr. 1897, p. 81	1	Left	M, 57	2 pelves and ureters on left. Ureters fused and entered bladder by one orifice
White	Path. Soc. Phila. 1898, xviii, 326	1	Left	M	2 pelves on left. The 2 ureters joined at about 1 inch from bladder
Rocher	Bull. Soc. anat. Paris, 1899, xx, 393	1	Left	F, 39	2 ureters on left side joined about 3 cm. from bladder
Lennander	Arch. f. Klin. Chir., 1900, lxi, 47	1	—	F, 29	2 ureters, 2 pelves on left joined before entering bladder. Found during operation
Gorron	Bull. Soc. anat. Paris, 1900, lxxv, 157	1	Left	—	

Bordeaux, Aubaret	Bull. Soc. anat. 1900, xxi, 87.	1	Right	Child	Antopsy. Duplicated right ureter joined at about 12 mm. from bladder
Keith	J. Anat. & Physiol. 1901, xxxv	1	Right	M, 8	Double pelvis and ureters
Sandder	Amer. Jour. med. S 6. 1901, exxii, 46	1	Right	F, 20	Laparotomy and antopsy. One ureter ended blindly in dilated sac
Lange	Ann. Surg. 1901, xxxiv, 581	1	Left	M, 56	2 pelves. Operated case
Munro	Ann. Surg. 1902, xxxv, 607	1	Right	F, 21	No double pelvis. The 2 right ureters joined before entering bladder. Nephrectomy finding
Constantin-Daniel	Bull. Soc. d'anat. 1903, xl	1	Right	Infant	Antopsy. Ureters on right joined at 1 cm. from bladder
Young	Monats. f. urol. 1903, viii, 591	1	Left	M, 54	Bifid ureter. 2 pelves
Kapsammer	Nierenchirurgie, ii, 1905, p. 121	1	Left	F, 46	Case 22. There were 2 left ureteral orifices but the two ureters used above and entered as a single tube into 1 pelvis
Kapsammer	Nierenchirurgie, ii, 1905, p. 121	1	Left	M, 54	Case 25. 2 pelves, 2 ureters joined at 12 cm. below lower pelvis.
Dutilleul and Leroy	Echo. Med. d. nord., 1903, vii, 347	1	Right	—	Antopsy. The ureter coalesced about 2 cm. from the bladder.
Thumin	Berl. Klin. Wehnsehr. 1905, xlii, 905	1	Right	F	Supernumerary ureter ended in retro- peritoneal cyst
Heresco	Soc. de chir. de Bucharest, Clin. Chirurg. 31, Mar. 1906	1	Right	—	2 pelves, used ureters

TABLE 6—continued

REPORTER	REFERENCE	NUM- BER OF CASES	SIDE	AGE AND SEX	REMARKS
Tilp	Prag. Med. Wehnschr. 1906, xxx, 327	3	—	—	Cases of supernumerary ureter ending in cyst in bladder wall
Wulff	Monats. f. urol., 1906, xi, 525	1	Left	—	2 pelves—from each a distinct ureter which united with each other before entering bladder. Demonstrated by operation
Saint Martin	Gaz. med. de Nantes, 1907, xxv, 272	1	Right	—	
Barling	Brit. Med. Jour. 1907, i, 498	1	Right	M, adult	3 ureters from 1 kidney pelvis, 2 co- alesced. There were 2 openings into the bladder
Robinson	Pediatrics, 1909, xvi, 605	11	6, right 5, left	—	
Kusnetsky	Zeitschr. f. urol. 1909, iii, 927	1	Right	M, 35	2 pelves. The 2 ureters united about 5 cm. from the bladder
Rafin	Lyon Med. 1909, cxii, 418.	1	Left	F, 30	Hydronephrosis; nephrectomy case for ureter bifurcated about 2 cm. from bladder, one branch going to healthy part of kidney
v. Federow	Zeitschr. f. urol., 1910, iv, 561	1	Left	F, 26	Supernumerary ureter ended in a re- tention cyst in bladder wall
Ginsburg	Proc. Path. Soc. Phila., 1910, xiii, 256	1	Left	—	

Cases of Van Horne, Huber, Pohl, Sandifort, Stoll, Bull. de la Fac. casc. Rayer, Lionville, Porter, Englisch (2 cases), Caille, Davis (4 cases), Sebileau and Mediana, Strube, Ely, Zuckerkandl, Morris, Brewer (5 cases), Zondek, Hauch, Delaboudiniere (3 cases) and Bohmer. Papin	Cited by Papin. Rev. de Gynec. et de chir. abdom. 1910, xv, 105	32	—	—	In 17 duplex of these cases there were pelves on the side of the double ureter
	Rev. de gynec. 1910, xv, 105	6	4, left 3, right	—	All had duplicated pelves
Maclaure & Sejournet	Bull. Soc. anat. Par. 1910, lxxv, 963	1	Right	—	
Verhaeghe & Fontan	Bull. Soc. de med. du Nord, 1911, p. 497	1	Left	—	Autopsy. 2 pelves, 2 ureters fused 3 cm. before entering bladder
Starek	Zeitschr. f. urol. 1911, v, 466	1	Left	F, 15½	With 2 pelves
Dorland	Surg. Gynec. & Obst., 1911, xiii, 303.	1	right	M, 45	
Jeanneney	Jour. de med. Bordeaux, 1912, xlii, 837	1	Right	—	Autopsy. 2 pelves. Ureters used 2 finger widths above the bladder
Nikolski	J. okush i jensk. boliez. St. Petersburg, 1912, xxvii, 495	2	Both right	Both F	Double pelves in both cases. In one case the 2 ureters fused about 15 mm. from the pelves; in the other near the bladder

TABLE 6—concluded

REPORTER	REFERENCE	NUM- BER OF CASES	SIDE	AGE AND SEX	REMARKS
Rolleston	Proc. Roy. Soc. of Med. 1912-13, vi, Sect. Dist. of Child. 114	1	Left	M, 12	Bifurcated at 3 inches from bladder
Braasch Suter	Ann. Surg. 1912, lvi, 726 Folia, urol. 1913, viii, 35	5 1	— Left	— F, 46	1 case had unilateral double pelvis Left double pelvis; one orifice in blad- der for both left ureters
Apert, Lemaux and Guillaumot	Bull. Soc. anat. Paris 1913, lxxxviii, p. 17	1	Left	M	Autopsy. Supplemental ureter had 3 branches which joined together and coalesced with the normal ureter Double pelvis; 1 kidney
Furniss	Amer. Jour. Obst. 1915, lxxi, 669	1	—	—	2 pelvises. The two ureters coalesced at 6 to 7 cm. from the bladder.
Beccherle	Polclin. Rome, 1915, sez. chir. xxii, 168	1	Right	F-28	Supernumerary ureter opened into vagina. Double pelvis not demon- strated. Operated
Judd	Surg. Gynec. & Obst. 1918, xxvii, 13.	1	Right	F, 48	Case 3. Double pelvis. 2 ureter joined just before they entered blad- der
LeGrand	Jour. Med. de Bruxelles, 1917, p. 117	1	Left	M, 35	2 pelvises in each case. Found in each case during operation
Eisendrath	Surg. Clin. of Chicago, 1917, i, 1053	2	Left	F, 47 F, 25	Case 4. Double pelvis. 2 ureters joined 35 mm. from bladder
Legrand	Jour. Med. de Bruxelles, 1917, p. 117	1	Left	F, 9	Double pelvis; bifurcated at about 6 cm. below lower pelvis
Young and Davis	Surg. Gynec. & Obst. 1918, xxvii, 1	1	Left	M, 57	

Bugbee and Losee	Surg. Gynec. & Obst. 1919, xxviii, 97. Cases 20 and 23 Cases 7, 8, 9, 11.	1 1 4	Left Right 3, right 1, left	F, 23 F, 29 —	Bifurcation 1½ cm. from bladder Single pelvis in this case Cases of pelvic unilateral duplication
Wossillo	Zeitsch. f. urol. 1920, xiv, 194.	1	Left	F	2 pelvises and 2 ureters on left; ureters joined about 6 cm. before entering the bladder
Harpster, Brown and Delcher		1	Left	F, 40	2 ureters. 2 pelvises. Diagnosed by pyelography
Crabtree and Shedden	Jour. Urology Sept. 1921	1	Right	—	2 ureters. 1 pelvis. Diagnosed by pyelography
Crowell	Jour. Urology Sept. 1921	1	Right	—	2 pelvises. 2 ureters. Diagnosed by pyelography
Mertz	Urolog. & Cutan Rev. 1921, xxii, 553	3	—	—	Either personal or collected unpublished cases
Total number of cases.....		114			

Albarran (13) had previously done this operation; and three cases were apparently so treated in the Mayo Clinic according to Braasch. Herrick (14) and Rumpel (15) also did successful resections in double kidney. Resection is of particular value in tuberculous kidney.

Bruci (7) remarks that one should be prudent in deciding upon resection in these cases even when the independent part of the kidney is apparently healthy, because even in this latter microscopical examination will frequently show little disseminated miliary abscesses. Bruci says that these are due either to the fact that the arteries are not terminated at the division of the kidney parts or because the septic matter travels through the lymphatics or by a more circuitous blood route.

The upper part of the double kidney is almost always the diseased part, but the lower part is more voluminous, its shape is more approximately normal, and its ureter is generally normally discharged. The upper part of the double kidney is from these considerations the supernumerary or abnormal part.

Sacquepee (10) observes that when the duplex ureters have orifices that are neighbors the kidney does not show any visible alteration, but if one orifice is abnormal, it is constantly found that the part of the kidney corresponding to the abnormal opening is diseased.

A good deal has been written regarding the cause of double ureter and double kidney. Pohlman (16) wrote an important article on the embryological origin of the condition, in 1905; Sacquepee (10) also deals with the embryology, discussing the earlier theories. Recently Young and Davis (12) have made a study of the embryology. These authors say that during embryological development of higher mammals there are three successive types of excretory organs: pronephros, mesonephros, and metanephros. The first two are temporary only and the third becomes the permanent kidney. All are of mesodermal origin from the nephrogenic cord. The pronephros has become atrophied before the embryo reaches the length of 5 mm. Its duct persists to form the Wolffian duct, the excretory duct of the mesonephros. The mesonephros or Wolffian body also

undergoes atrophy in the human embryo. Its duct persists as the vas deferens in the male and Gartner's duct in the female. The metanephros appears first as a budding or evagination from the lower end of the Wolffian duct. This bud is destined to form the ureter, pelvis, calyces, and collecting tubules, viz. the whole efferent apparatus, while the secretory portion of the kidney is derived from a mass of mesodermal cells forming the so-called metanephrogenic tissue originating from the caudal portion of the nephrogenic cord.

About the 8 mm. stage of embryonic life the metanephros bud splits into upper and lower divisions the first evidence of the calyces. The formation of incomplete double ureter is according to most authors accounted for by a premature or exaggerated bifurcation of the tip of the ureteral bud, the split extending down the ureteral stalk instead of being confined to the tip. Regarding complete double ureter, some consider it as resulting from separate outbuddings from the Wolffian duct.

According to Sacquepee the Wolffian duct by splitting gives origin to the Muellerian duct. In the male the lower portion of the Wolffian duct becomes the vas deferens and prostate and the Muellerian duct atrophies. In the female the Muellerian duct forms the uterus, ovaries and tubes and the lower part of the Wolffian duct atrophies. Double ureter and double kidney may arise from persistence of those ducts which normally atrophy. Sacquepee says that when double ureter is found without double kidney or that the ureteral ends terminate in cysts a persistent Wolffian or Muellerian duct must be thought of.

The question of the origin of the various anomalies is by no means clear and none of the explanations given up to now seem satisfactorily to account for all types of anomaly.

The important point for practical medicine, however, is that these anomalies occur with a far greater amount of frequency than the average practitioner has believed, and that this frequency warrants and compels every urologist and surgeon to consider the occurrence of such anomalies as very possible and probable and to act accordingly.

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Accompanied by six tables

Table 1.	Complete bilateral duplication	40
Table 2.	Incomplete bilateral duplication.....	28
Table 3.	Complete unilateral duplication with supernumerary kidney	10
Table 4.	Complete unilateral duplication with fused kidney.....	171
Table 5.	Incomplete unilateral duplication with supernumerary kidney	9
Table 6.	Incomplete unilateral duplication.....	124
	Total	382

REPORT OF A CASE OF EXTREME DILATATION OF THE URETERS

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The following case is deemed of sufficient interest to warrant it being reported:

Man, aged thirty-seven when seen first April 3, 1918.

Chief complaint. Frequency of urination with occasional burning. Has had this "bladder trouble" for the past ten years beginning with rather slight symptoms gradually increasing up to the present. He now urinates about every hour during the day and about every two hours during the night. The desire to urinate when it comes is rather urgent. During his illness he has consulted various physicians and for fifteen months preceding the time I saw him he was under the care of a competent urologist. Immediately preceding the time I saw him he had consulted a general surgeon in Brooklyn who had made a diagnosis of bilateral renal tuberculosis.

Previous history. Infantile paralysis at two and a half years of age which probably involved the muscles of the back and abdomen along with the muscles of the right leg and thigh. At the age of fourteen he noticed that his spine was beginning to curve.

Examination. Short in stature with a very marked scoliosis of the lower dorsal and lumbar spines with some rotation. Right leg and thigh atrophied. Total loss of function of the quadriceps extensor.

Neither kidney palpable; rectal; prostate flat, not tender; vesicles, not felt.

Cystoscopic. Bladder: residual, none; capacity 4 ounces; mucous membrane normal, smooth and glistening, slight congestion at apex of trigone. Ureteral orifices much enlarged, the right one appearing about 1 cm. across and the left one half that size. Catheters introduced easily to each kidney. With the ureteral orifices dilated as they were it

¹ Read before the American Urological Association, Atlantic City, New Jersey, April, 1922.

was evident that whatever fluid was introduced into the bladder would go to the kidneys and thus come down the catheters, therefore the cystoscope was removed and a catheter introduced into the bladder and through it sodium bromide injected. An X-ray plate was made which is here shown.



FIG. 1

The urine has been repeatedly negative for tubercle bacilli both by stain and guinea-pig inoculation and revealed a very small amount of pus in one specimen out of many examined.

The important facts concerning this case are that he had infantile paralysis at two and a half years of age; that he has a curvature of the spine which began at age fourteen; that in the urinary tract he has no

apparent obstruction to urinary outflow and no interference with the mechanism of urination; the bladder is markedly contracted, the ureters and pelves markedly dilated. There is at present no signs of infection. The chief interest in this patient lies in the etiology. It is quite apparent nothing can be done for him.

Dilatation of the ureters such as is presented here may be due to the following causes:

1. Mechanical obstruction: (a) congenital, (b) acquired.
2. Infection.
3. Disturbances of innervation.

There is no evidence of obstruction anywhere along the urinary tract so that this as a cause can be ruled out.

It is possible that he may have had a severe infection at the time of his first urinary symptoms, that he survived the infection and that the whole condition as here presented is the result, namely, the dilated ureters and pelves, and the contracted, rigid thick walled bladder.

The possibility of disturbance of innervation must be considered as a very strong etiologic factor. In all the cases reported in the literature, with paralysis as a possible cause, none of them gives a history of having had infantile paralysis. Lack of intimate knowledge of the innervation and mechanism of urination prevents certainty in this field. Neurologists who have seen this patient and those with whom I have talked on the subject assure me that it is quite impossible for infantile paralysis to have caused this condition, yet they all admit that the urinary tract is frequently affected in this disease particularly when there is involvement of the abdominal and thigh muscles. Just how the urinary tract is involved no one seems to know. It is possible that the uretero-vesical valve was affected to a point of insufficiency and that this continued insufficiency produced the condition here shown.

There are cases mentioned by various authors in which no etiologic factor can be found and this may be one of them, however the above comment is worthy of consideration.

SUPERNUMERARY URETERS WITH EXTRAVESICAL OPENINGS¹

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Duplication of the ureter is a very frequent malformation but the extravesical opening of a supernumerary ureter is rare. It has been my good fortune to see 1 case with four ureters and 21 with three; however, the only ones of this number having other points of interest were 2 with extravesical openings. In 1913, Hartman reviewed the literature of ureters opening extravesically, both single and supernumerary. Up to that time he found records of 37 cases, 19 of which had been operated upon. Kelly and Burnham in their review of the literature report 9 more, 2 of which were their own. In addition to these, E. S. Judd has reported 2, Tovey 1, and I myself 2, bringing the total number up to 51.

To properly understand the development of these anomalies a study of embryology is necessary. The best articles in English that I have been able to find are those of Hugh Young and Kelly and Burnham, and it is from Kelly and Burnham that the brief description given below, in part verbatim, has been taken.

The ureter arises as a process from the hind wall of the lower end of the Wolffian duct. The distal end of this bud grows into the kidney and, as the kidney ascends into the lumbar region, the ureter lengthens—at first the ureter opens into the Wolffian duct, but later it opens with the Wolffian duct into the urogenital sinus. Should the Wolffian duct or the ureter fail to shift anterior from the cloaca before the urorectal septum divides the rectum and bladder, the ureter empties into the rectum. In the female, should there be a failure of separation of the Wolffian

¹ Read at the meeting of the American Urological Association, Atlantic City, New Jersey, April, 1922.

duct and the ureter, the ureter will be connected with Gartner's ducts and the structure developing from the Wolffian duct, namely, the urethra, and the vestibule of the vagina.

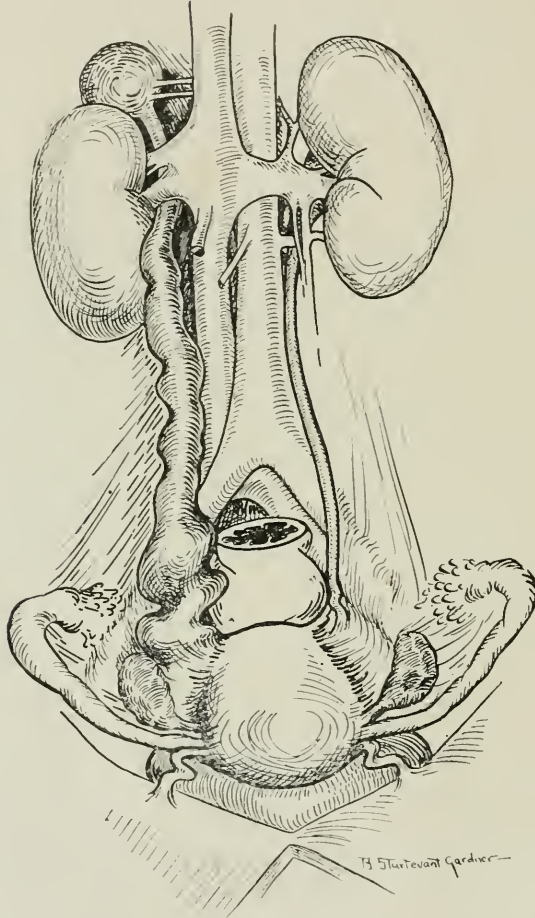


FIG. 1. The enlarged supernumerary ureter is shown draining the small upper portion of the kidney. This portion of the kidney had its own blood supply, and was separated from the larger portion without bleeding. The supernumerary ureter was greatly dilated. The two ureters were closely attached, but were easily dissected free.

Of the several theories advanced to explain the double ureter the most plausible is that there are two separate evaginations from the Wolffian duct. In the process of downward growth the

lower ureter reaches the bladder first, usually in the place where the normal ureter is found, while the upper ureter continues its downward shifting together with the Wolffian duct, mesially to the first attached ureter until it reaches the urogenital sinus. The Wolffian duct minus the ureter continues to shift to a still lower level. If the two ureters are liberated in quick succession they will be found close together in the bladder; if a long interval prevails they are further apart so that the upper ureter may be carried even to or below the internal urethral orifice.

The practical points learned from this embryologic study are:

1. A double ureter may unite at any point between the bladder and kidney and empty into the bladder as a single tube.

2. When there are two separate openings the ureter runs as a single opening to the bladder.

3. The ureter opening most caudad comes from the cephalad portion of the kidney and that from the lower pole occupies the more normal position in the bladder.

4. The ureteral opening, when in the urethra, is always on the floor and never on the roof or lateral walls.

5. When the ureteral opening is in the vagina it is on the anterior wall and never on the lateral wall.

6. The ureter emptying lowermost crosses and lies to the inner side and behind the more normally situated ureter.

7. In the female the ureter may empty into the vagina, the vestibule of the vagina, the fallopian tubes or uterus, or Gartner's duct. In a number of non-viable fetuses openings into the rectum, intestines and allantoic cavities have been discovered. In the reported cases the openings have been:

First, in the urethra. In 2 of these the opening was through the sphincter and there was fairly good urinary control. In 1 of these 2 the incontinence did not appear until after the third labor. In still another, the continence was good even though the opening was anterior to the sphincter—this case was discovered as a post-mortem finding.

Second, into the vestibule. Most of the recorded cases have had an opening in this location and it has usually been just below the external urethral meatus and slightly lateral. It has usually been described as of slit form.

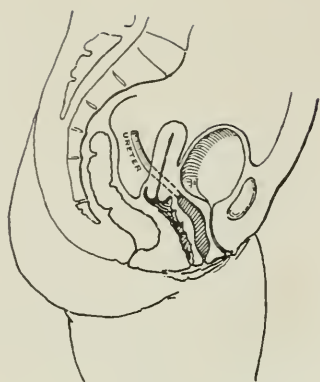


Fig 2

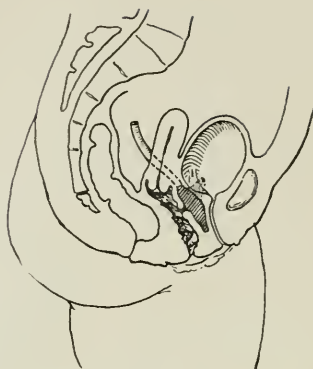


Fig 3

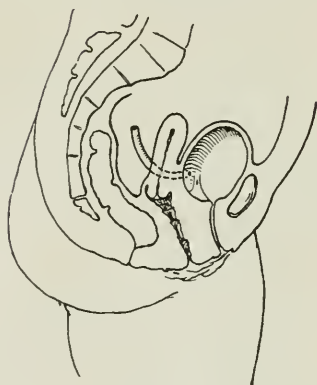


Fig 4

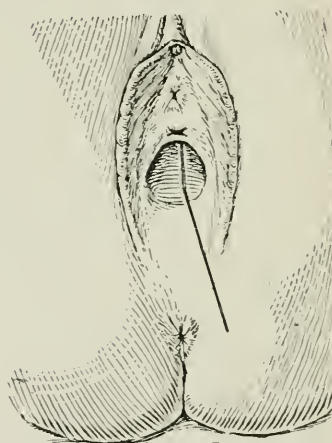


Fig 5

FIG. 2. The dilated distal end of the supernumerary ureter shown as a fusiform sac, with a minute orifice below the urethra.

FIG. 3. The result of the first operation—an opening between the dilated lower end of the supernumerary ureter and the bladder; and an opening between the ureter and the vagina, the result of failure of union of the vaginal wound.

FIG. 4. The end result—the supernumerary ureter implanted in the bladder.

FIG. 5. The opening of the supernumerary ureter is shown below the ureter. In life this was not so large nor so distinct. The line shows the incision made through the perineum to gain access to the base of the bladder.

Third, into the vagina. The opening in most of the cases has been below the urethra and slightly lateral.

No matter where the opening has been, in a good majority of cases the lower end of the ureter has been dilated, either as a small sac, or as a fusiform swelling. In many instances this dilatation extended to the kidney which was found to be atrophic in the part drained by the supernumerary ureter. Probably further study will show that with accessory extravesical openings the upper pole will be found quite rudimentary. This rudimentary development, however, does not always hold true in the cases of double ureters where the opening is intravesical as shown in 1 operated case reported by Hugh Young; 1 operated case, and 1 post-mortem finding seen by myself, in all of which, the kidney tissue drained by the two ureters was fairly evenly divided. In the numerous pyelographs that have been made of double ureters, the size of the pelves would indicate the same.

HISTORY

The usual history given is that of constant dribbling night and day in addition to normal voiding, existing since birth. In a few patients with this condition, the control has been fairly good; in 1 the onset of the trouble was after labor; and in another, it was made worse by childbearing. Where there is such good control the opening has been through the sphincter as a rule, though in 1 case the opening was anterior to the sphincter and there was no dribbling during life. The condition was discovered at autopsy. At times the incontinence is made worse by pressure over the abdomen or straining. This can be explained on the ground that there is a marked hydroureter which discharges more frequently when the tension is increased.

Even with such a suggestive history it is a noteworthy fact that the condition has remained unrecognized in nearly all the cases until adult life. In 1 it was discovered at the age of five years, which is the youngest case recorded. I think that this lack of appreciation is due to the fact that the average doctor is unaware that such an anomaly does or can exist. With a his-

tory so suggestive a suspicion of an extravescical ureter is excited and this suspicion should be adhered to until some other cause for the incontinence can be determined. I grant that it is difficult at times to discover the orifice in an extravescical ureter, and even, at times, impossible. In some instances there is only a very small amount of renal tissue functioning, and this excretes fluid in such small quantities, or eliminates dyes so slowly and incompletely, that the point of drainage cannot be determined. The unwary are put on a wrong scent by discovering two normally situated and functioning ureters. This is a much more frequent occurrence than to have a single ureter open extravescically. Where such a condition is suspected and simple inspection does not reveal the opening, the patient should be given indigo-carmin intravenously and pledgets of cotton placed in the urethra and vestibule. Should sufficient dye be eliminated the stained spot will give a clue to the location of the opening. At times there is so little dye eliminated, or the ureter is so dilated, and the dye so diluted that the cotton will not be stained. In such a case it is well to give three or four 1 grain doses of methylene blue and have the patient return the next day when it may be possible that the staining will be sufficient to enable one to locate the orifice. Should the ureter be in the urethra, endoscopy may disclose it.

Often the dilated portion of the ureter will be felt as a swelling beneath the urethra or in the anterior wall; pressure over which may cause the extrusion of fluid. When such direct evidence is not to be obtained we may get our information indirectly. Should the history clearly indicate a ureter opening extravescically, an irregularly shaped kidney—especially if the irregularity is a small nodule at the upper pole—would be very strong corroborative evidence. Such an irregularity might be determined by palpation in thin patients with ptosed kidneys, or by X-ray plates sufficiently good to nicely delineate the kidney. It is possible that pictures after Corelli's technique will show this much more satisfactorily. A pyelograph made by injecting the vesical ureter would show the absence of the upper calyx, if the kidney had two pelves, and also give an idea of the relative size

of the kidney portions drained by the two ureters. Not only should the presence of the supernumerary ureter be determined, but also the function of the two kidneys; the function of the different parts of the kidney drained by the two ureters; the extent the ureter is dilated, and whether or not there is infection. Each of these is a factor in determining proper treatment.

In the cases that have been reported the following operations have been done.

1. Ligation.

2. Anastomosis of the dilated end of the ureter and bladder, done either from the bladder or vaginal side after a suprapubic cystotomy. Hunner in one instance through a Kelly endoscope made an opening from the bladder into the dilated ureter with a cautery.

3. Implantation of the ureter into the bladder, either by a vaginal plastic or abdominal operation—both intraperitoneally and extraperitoneally.

4. Resection of the upper pole of the kidney.

There have been successes and failures in all these operations except the resections. Even in those reported as successes, a number have had subsequent histories of pyelitis, stricture of the ureter, or cessation of function of that portion of the kidney drained by the extravesical ureter. This is not surprising when it is remembered that in a number of these the ureter has been dilated and there has been present infection. Even under most favorable circumstances the ultimate results in uretero-vesical anastomosis have not always been satisfactory on account of subsequent stricturing of the implanted ureter, with dilatation and infection.

In formulating plans for treatment each case has to be individualized and treated accordingly. However, I think the cases may be divided in the following groups:

1. *Cases suitable for uretero-vesical anastomosis.* Those showing a goodly amount of renal tissue drained by the accessory ureter; no infection; good function and absence of hydroureter and hydronephrosis. The choice of the vaginal or abdominal route for this implantation is dependent on the condition of the lower

end of the ureter. Should it be easy to dissect it out and should it not be dilated, implantation per vaginam is a simpler and safer procedure than by the abdomen. Should this be a failure the result is not serious and an abdominal implantation can be done at a later date. I believe that the extraperitoneal operation for this implantation is the better and safer procedure.

2. *Cases suitable for simple ligation.* Those showing only a small amount of renal tissue drained by the accessory ureter; no dilatation of the ureter or pelvis and no infection.

3. *Cases suitable for resection.* Those showing a small amount of renal tissue, or dilated ureter and pelvis, or infection—one or all of which are indications for resection.

As the majority of cases fall in this category, I feel that resection is the best procedure. Its advantages are that it is less difficult, less dangerous, more certain in results and not so apt to be followed by delayed complications. As the renal vessels are terminal, there is very little difficulty in controlling bleeding. Young, Eli, Legueu, Josephson and I have been well satisfied with this procedure and consider it the method of choice.

Case 1. A girl of nineteen, who came on account of incessant dribbling of urine since birth. She voided as other normal girls. This history pointed clearly to some congenital anomaly, one in which urine was discharged distal to the urethra. With this in mind she was cystoscoped after intravenous injection of indigo-carmin. The dye was eliminated promptly through normally situated right and left ureters. The vagina and the vestibule were packed with cotton. After a wait of ten minutes it was found that the cotton just below the urethral meatus was stained. A careful search revealed a minute opening, into which a ureteral catheter could be introduced 4 inches. Vaginal palpation showed this to run to the left side.

Operation. After catheterizing the ureter an attempt was made to dissect it out, and turn it into the bladder. A thin fusiform sac intimately adherent was found. This was opened accidentally. After this an incision was made into the bladder through the opposite wall of the sac and the vesical and ureteral mucosae united with catgut. The distal end of the ureter was closed; the accidental wound sutured, and the

vagina brought over it with chromic catgut. A retention catheter was placed in the bladder.

Seven days after operation the old ureteral leakage returned. After three weeks the ureter was exposed through the vagina, and it was then found to be about twice the normal thickness on the kidney side of the fusiform sac. After mobilizing $\frac{3}{4}$ inch of the ureter, a sound was placed in the bladder, made to depress the bladder just in front of the ureter. A hole was cut at this point, a suture placed through the ureter and tied to the sound. On withdrawing the sound the ureter was pulled into the bladder, where it was sutured with chromic catgut and the vaginal wound closed.

The incontinence was cured. After operation the new opening was shown to function by the appearance of indigo-carmin elimination, but after six months this ceased. Attempts to catheterize this ureter were vain.

Case 2. A woman of thirty-eight with a history of incessant dribbling and normal micturition. Cystoscopy showed two normally placed ureters, both eliminating indigo-carmin promptly, but an opening of an extravasical ureter could not be found. Cotton pledgets were placed after indigo-carmin administration to detect any extravasical discharge but none was found. On vaginal examination the urethra appeared more full and prominent than usual. A metal catheter was placed in the bladder and the urethra again palpated without detecting any swelling beneath.

The patient had a fibroid uterus the size of a grape fruit, and, because of three-weekly profuse bleeding, I did a supravaginal hysterectomy. On the right side of the pelvis was found a soft elastic swelling which was extraperitoneal, about $\frac{3}{4}$ inch in diameter, running from below upwards over the brim of the pelvis. The history, together with the knowledge of two normally placed ureters, each promptly eliminating indigo-carmin, gave the clue to the diagnosis. Palpation of the right kidney showed a mass the size of a hickory nut on the superior pole.

Not trusting to the efficacy of simple ligation of the ureter, an upper right rectus incision was made into the peritoneal cavity. An incision was made through the peritoneum on the outer side of the colon which, when displaced inwards, exposed the kidney. The dilated ureter was in front of the other ureter and closely connected. At the pelvic brim the dilated ureter so overlay the other that it was not to be seen. The ureter 3 inches from the pelvis was freed, double clamped and cut. The

lower end was ligated with chromic catgut and dropped. The renal end was freed up to the vessels going to the lower part of the kidney and then passed above them. It normally ran posteriorly to the vessels. The kidney was normal in size with the part attached to the extra-ureter perched on top. Two small arteries ran to it—the veins could not be well shown. This part of the kidney was represented by a sack $\frac{3}{4}$ inch in diameter, with a small layer of kidney tissue attached to the kidney, the whole being enclosed in a fibrous capsule. It was resected without difficulty and without bleeding.

A stab wound was made in the flank, through which a cigarette drain was placed, the posterior peritoneal incision, the anterior peritoneal incision, and the abdominal wall were closed. There was only slight bloody drainage. The drain was removed on the second day. Uneventful convalescence with complete relief of urinary drainage. On two subsequent examinations the opening of the ureter could not be found.

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PATHOLOGIC COMPLICATIONS WITH DUPLICATION OF THE RENAL PELVIS AND URETER (DOUBLE KIDNEY)¹

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Anomalies in the urinary tract of themselves are of no clinical significance. It is only when some pathologic complication occurs that their recognition becomes of clinical as well as of surgical importance. Pathologic and particularly surgical complications are prone to develop in the presence of such anomalies, and their clinical discovery is, therefore, comparatively frequent.

The most common anomaly in the urinary tract is duplication of the renal pelvis and ureter; such duplication may be unilateral or bilateral, complete or incomplete. When it occurs in a solitary kidney it is usually termed fused or horseshoe kidney. That duplication is comparatively common is evident from the literature; in fact it is so common that its discovery is not generally reported unless some unusual incident accompanies it. An excellent review of 300 cases largely collected from the literature is given by Mertz in a recent series of papers. It is of interest that in 27 per cent of these cases the duplication was bilateral. The comparatively high incidence of ectopic ending of the duplicated ureter as reported in the literature is also of unusual interest; this occurred in 42 (30 per cent) of a series of 140 patients having complete ureteral duplication.

One hundred forty-four patients with duplication of the renal pelvis and ureter were observed in the Mayo Clinic from 1907 to 1922. The conditions were divided anatomically into unilateral, 135 (94 per cent), and bilateral, 9 (6 per cent). The

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duplication of the ureter was subdivided into complete unilateral, 36 (25 per cent); incomplete unilateral, 99 (68.7 per cent); complete bilateral, 8 (5.5 per cent), and incomplete bilateral, 1 (0.7 per cent). In the complete unilateral duplications there was an ectopic ending of the duplicated ureter in 3 cases (2 per cent). Doubtless the relative occurrence of bilateral duplication reported in this series is not exact, particularly in relation to the occurrence of partial duplication of the ureter. Nevertheless, it is hardly possible that the percentage of error in our cases would approximate the bilateral occurrence of 27 per cent as found by Mertz. The comparatively large number of patients with bilateral duplication reported in the literature may be explained by the fact that this unusual condition is reported, while the more ordinary unilateral occurrence is not. The comparatively common occurrence of ectopic ending of the duplicated ureter as reported in the literature probably is also exaggerated and can be similarly explained.

ANATOMY

The position of the kidney with duplicated pelvis and its relation to the surrounding tissues are usually normal. The double kidney which is usually larger than normal varies in size, as a rule, with the distance separating the pelves. The two renal segments are generally separated externally by a depression which varies from a shallow notch to a deep broad groove; occasionally this external evidence of division may be lacking or it may be so marked that only a fibrous band unites the two segments, as in a case described by Marion. Although there may be a definite external division of the two renal segments and the pelves may be widely separated, our microscopic examination of the intervening tissues showed that there was no apparent division in the cellular structure of the two segments. In an occasional case the two pelves are so close together that a partial resection is impossible. When external demarcation of the two segments exists, the upper segment is, in most cases, smaller than the lower. Even though the double kidney is somewhat larger than ordinary, the combined renal function of the two

segments is generally normal. Although there is usually a difference in size between the pelves of the two segments, we have found that the differential function of one segment is usually equal to that of the other. In 2 instances the phenolsulphone-phthalein return from each segment was 7 per cent in fifteen minutes.

The division of the tip of the renal bud into the branches of the renal pelvis may give rise to a great variety of forms. The usual short cleavage of the ureteral bud sometimes continues and forms partial duplication of the pelvis. One of these divisions or calices (usually the cephalad) may form a pelvis as large as the original. As a result of ureteral obstruction in this type of case hydronephrosis, when it occurs, will involve both pelves. Duplication of the pelvis may be said to be complete only when the several pelves or their portions have separate ureters or ureteral divisions. Sometimes the renal bud divides into three or four separate elongated calices, each of which has a separate branch running to the ureter; these unite just beyond the hilum without forming a true pelvis. In 1 of the cases of this series (case A308206) the pelvis was entirely extrarenal, situated about 6 cm. from the hilum of the kidney, and above it the two major calices extended into the renal substance where they divided into the minor calices. Occasionally, the ureteral divisions leading from the duplicated pelves will unite close to the kidney, or even within the kidney, so that resection or division of the ureter is obviously impossible (Fig. 1).

In cases of complete duplication of the ureter crossing often occurs just above the bladder and also below the ureteropelvic juncture; but this is probably not of clinical importance. Often, there is only one crossing or none at all; occasionally the two ureters are wound around each other, or they are in close apposition and may be inclosed partially or entirely in a common sheath, adding greatly to the difficulty of preserving the sound ureter following a partial resection of the kidney with the attached ureter. As a rule, the ureters leave the pelves at a normal angle; in incomplete duplication the ureteral division may occur at any level.



FIG. 1. CASE A199670
Partial duplication of kidney with normal minor calices



FIG. 2. CASE A241859
Duplication with fusion of ureters in the upper third

In our series the upper one-third of the ureter was most often duplicated (fig. 2). Ectopic ending of an aberrant ureter has been described as occurring in the vagina, urethra, seminal vesicle, ejaculatory ducts, and in the other anatomic areas represented by the permanent disposition of the wolffian duct. In our series ectopic ending was found in the urethra in two instances and in the vagina in one.

HISTOLOGIC STRUCTURE

Sections taken from the interrenal tissue in most cases show complete histologic unity of the two segments. In some cases the capsule dips down into the renal mass, causing a partial division of the renal tissue. In the specimens examined glomeruli were commonly found in the parenchyma between the two pelves. In 1 case the tubules of the two segments were adjacent but definitely separated, each associated with its own glomerulus. Various transitions from an almost complete separation by fibrous tissue to an indistinguishable intermingling of parts were found. In cases of infection the intervening tissues invariably showed round-cell infiltration and fibrosis, and in a few, destruction of the parenchymal or tubular cells. These pathologic cellular changes extended into the apparently normal segment to a variable extent.

DIAGNOSIS

As a rule, under normal conditions, complete duplication of the pelvis and ureter can be diagnosed with comparative ease. The condition is usually recognized by cystoscopic inspection, or more definitely by the aid of lead catheters and the pyelo-ureterogram (fig. 3). If the duplication of the ureter is incomplete and occurs above the bladder it cannot be discovered unless a routine pyelo-ureterogram is made. The presence of a pathologic complication in one or both segments and the resulting deformity may render recognition of the condition exceedingly difficult.

Cystoscopic inspection

The cystoscopist, accustomed to finding one ureteral opening on each side of the trigone, does not usually look for a third. The careful observer, however, should always be on the lookout for the third orifice. The duplicated orifices are usually situated at the normal site in the lateral portion of the trigone, separated by a distance of 1 to 2 cm. They are both as a rule, easily seen



FIG. 3. CASE A331059

Complete unilateral duplication with small upper and moderately dilated lower pelvis.

in the normal bladder in the comparatively small field of the direct vision cystoscope. The openings may, however, be very widely separated and are occasionally situated in unusual portions of the bladder. When they are widely separated the cystoscopist is not always to blame for failure to find the supernumerary orifice, and for overlooking the duplication.

An aberrant ureter, opening into the urethra or vagina, may be difficult to find, but the use of indigocarmine, as suggested by

Mertz, facilitates the discovery. Since urinary incontinence is present in this condition, every case of incontinence which is not otherwise explained should suggest the possibility of the ectopic opening of an accessory ureter.

If pathologic complications have not obscured the opening of the diseased ureter or caused marked abnormality in the bladder, the duplicated openings will have no unusual characteristics. Occasionally one or both may be small, or situated on a slight papilla and easily overlooked. Slight depressions may be visible in the mucosa adjacent to an orifice which may be suggestive of a duplication, and thus confused by an over-zealous observer. A ureteral orifice in or adjacent to the sphincter may easily be overlooked, particularly if the average lens cystoscope is used. When the ureter is divided above the bladder, there is, of course, but one orifice and this will not present any peculiarities suggestive of duplication. Complete bilateral duplication of the ureter and pelvis, with four ureteral openings in the bladder, should be no more difficult to recognize than unilateral duplication. The two ureteral openings may be found in the usual position on each side of the trigone. If tuberculosis involves one pelvis and ureter, the resulting contraction of the ureter may place the duplicated openings in unusual positions. As the result of the infection, deformity of the bladder and changes in the mucosa adjacent to the affected orifice may obscure them. In cases of atrophy of the ureter leading from a functionless renal segment the orifice may become obliterated.

Ureteral catheterization

Data obtained by means of the ureteral catheter alone in cases of complete unilateral duplication of the ureters is not of much practical importance, except with regard to the existence of pathologic complications in the ureter. The usual method of catheterizing the three ureters consists of a preliminary catheterization of one, followed by removal of the cystoscope and its reintroduction in order to catheterize the other two. The procedure which may be attended by technical difficulties and discomfort to the patient, can be obviated by the use of a three-

catheter guide which we have constructed in order to permit simultaneous catheterization of the three ureters (fig. 4). The question may arise, in cases of duplicated pelvis, as to whether there is a direct connection between the two pelves. This can readily be ascertained by injecting a solution colored with methy-

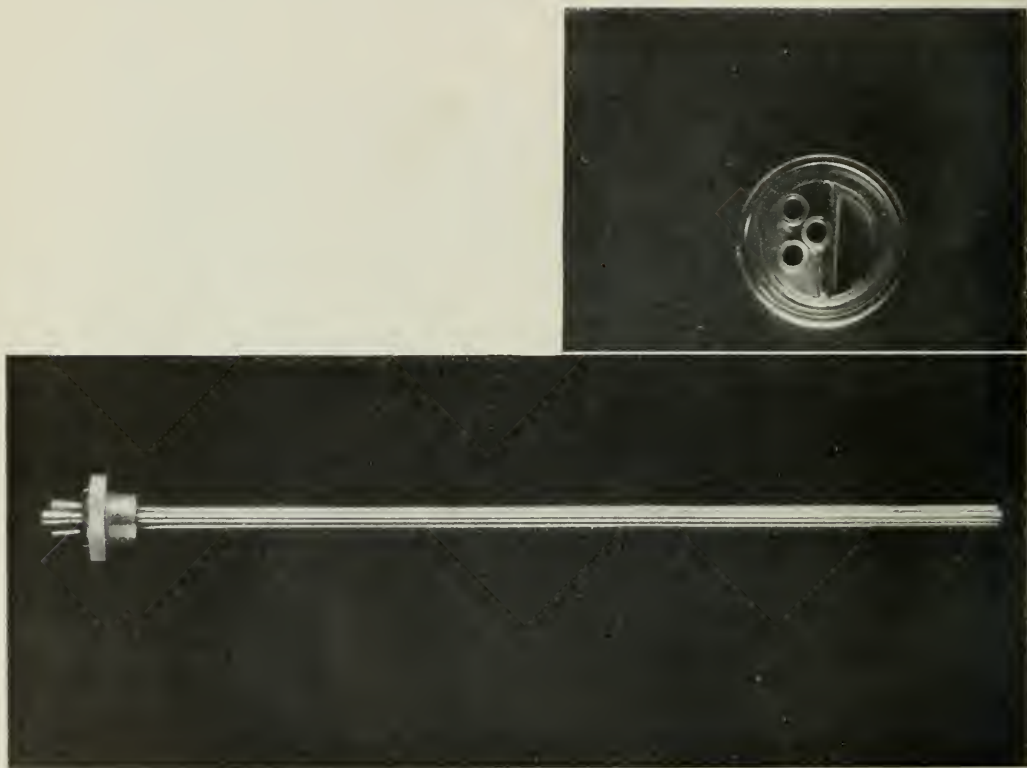


FIG. 4. *a*, CATHETERIZING GUIDE FOR THREE CATHETERS; *b*, END OF CATHETERIZING GUIDE

lene blue into one catheter; if the dye returns immediately from the second catheter, it is quite evident that the separation of the two pelves is incomplete. Further corroboration is available by means of pyelography. If the two ureters unite soon after leaving their respective openings, as occurred in one case previously reported (2), (3), the second catheter introduced will

meet the obstruction at the point of union. If there is a single opening and the ureter is divided in the upper portion, obstruction or any other evidence of the division is seldom found by the ureteral catheter.

It is often of value to estimate the comparative function in the two segments of the double kidney. In the diseased segment the extent of the pathologic process may be estimated, if the dye secretion is absent or greatly diminished. Of even greater value is the determination of the degree of function in the supposedly normal segment. If the return of the dye from this segment is greatly diminished, heminephrectomy should, of course, not be considered, even though the exterior of the segment appears fairly normal.

Pyelo-ureterography

More exact data concerning the anatomic structure of the duplicated pelvis and ureter, as well as on pathologic complications may be obtained by combining the roentgen ray and the cystoscope as in the pyelogram and the ureterogram (figs. 5 and 6). If duplication is complete, the lead catheter will outline the course of the two ureters and the position of the two pelves in the pyelo-ureterogram. The lead catheter will be of little value, however, if the ureter is divided above the bladder, since it can follow but one branch. The pyelo-ureterogram offers the only method by which such partial duplication can be determined (fig. 7). With incomplete duplication of the ureter, even though the end of the catheter is in one of the pelves, the injected bromid solution will usually flow back alongside the catheter so as to outline the divisions of the ureter and the second pelvis as well. When the ureteral division is close to the bladder the second ureter may be outlined by reinjection through the partially withdrawn catheter, as is routinely done at the Clinic in pyelo-ureterography.

The relation of the two pelves as outlined in the pyelogram may be of value in determining, first, the distance separating them, second, direct communication, and third, the relative size. By routine pyelo-ureterography at the time of cystoscopy, incomplete duplication undoubtedly will be discovered more

often in the future. It is of practical importance to ascertain as nearly as possible, the amount of tissue separating the two



FIG. 5. CASE A293833

Opaque catheters inserted into both pelves of double kidney. The lower pelvis injected with sodium bromid.

pelves, since if there is considerable, surgical separation is much easier. There is usually a marked difference in the outline of the two pelves, as well as in the size. The smaller pelvis is usually

situated cephalad and its calices are smaller than normal in size and contour (fig. 8). If a small pelvis is outlined in the



FIG. 6. CASE A296690

Complete bilateral duplication. Opaque catheters inserted in right ureters. Pelves of the left kidney injected with sodium bromid.

pyelogram and, particularly if it is high lying, the possibility of duplication with occlusion of the other ureter and pelvis must be considered and a search made for evidence. Obliteration of



FIG. 7. CASE A277876
Three separate pelvis leading from a common ureter



FIG. 8. CASE A299173
Complete unilateral duplication; moderate hydronephrosis in the lower segment.

one branch of a double ureter may be surmised when the branch of the ureter leading to the normal pelvis is smaller than the combined ureter. The point of ureteral division may be indicated by a localized irregularity in cases in which the smaller normal branch leaves the combined ureter. Even though data from cystoscopic inspection and ureteral catheterization are negative, the existence of duplicated pelves and ureters must be



FIG. 9. CASE A308528

Upper pelvis injected with sodium bromid. The lower pelvis is filled with stones.

considered if, first, the patient's recent history is suggestive of renal involvement; second, there is much pus in the urine without apparent cause, being found on cystoscopic inspection, or third, there are shadows suggestive of stone in the renal region which are apparently excluded in the pyelogram. The duplicated ureter or pelvis may become occluded so that cystoscopic data are negative and the pyelogram does not show the duplication.

In case of recent occlusion of one branch of a duplicated ureter it is easily possible that a pathologic complication in the involved pelvis would be overlooked. In a pyelogram the shadows of stones or of a calcareous area of tuberculosis situated in the occluded portion of the double kidney, might appear to be extrarenal because of their distance from the outlined pelvis (fig. 9). The same error would, of course, arise in the presence of complete duplication of the ureter when the second orifice is overlooked on cystoscopic examination.

PATHOLOGIC COMPLICATIONS

Mertz found that pathologic complications occurred in 80 (30 per cent) of the 300 cases reported. The 144 patients in our series may be divided, according to incidence of pathologic conditions, into: Group 1, those who were operated on, 30; group 2, those having definite pathologic lesions who were not operated on, 24; group 3, those in whom the evidence of pathologic lesions was doubtful, 29, and group 4, those without evidence of pathologic complication in whom the discovery of the condition was purely accidental, 61 (42 per cent). Fifty-four (37.5 per cent) of the 144 patients were found to be suffering with definite pathologic complications (groups 1 and 2).

In the 30 patients in group 1 who were operated on, the various lesions described were: ureteral obstruction with hydronephrosis or pyonephrosis in 8, renal tuberculosis in 6, renal lithiasis in 7, ureteral lithiasis in 3, and atrophic pyelonephritis in 4. In 1 case the aberrant ureter from the upper segment opened into the vagina; in another an anomalous vessel crossed the ureter causing obstruction. The lower segment of the kidney was primarily involved in 9, and the upper in 5; both segments seemed equally involved in 13. It is evident that the pathologic complication is confined largely, if not entirely, to one segment in about one-half of the cases, and, furthermore, that the lower segment is more often affected than the upper.

Of the 24 patients in group 2 who were not operated on, essential hematuria occurred in 4, unilateral infection in 2, bilateral infection (1 incomplete bilateral duplication) in 9, ptosis in 3, ureteral

stones passed after manipulation in 3, and stone in the lower pelvis of a double kidney, left intact because of various complications in 3.

The fact that 15 of the 24 patients had chronic renal infection is suggestive of possible lowered resistance because of the anatomic deformity. The 3 stones removed by manipulation were all near the uretero-vesical juncture and not related to the division of the ureter.

The 29 patients, in whom no definite evidence of disease was determined, had attacks of pain suggestive of renal colic referred to the renal and ureteral areas. In many cases the pain was accompanied by fever and chills with temporary urinary symptoms. Neither by cystoscopic examination nor urography could definite evidence of a lesion be demonstrated, although in several instances the pyelogram showed moderate distention of the calices. General examination did not reveal extrarenal cause of the symptoms in the majority of cases. It would seem logical to assume that the anatomic deformity was subject to temporary urinary obstruction or infection.

SURGICAL TREATMENT

Thirty operations were performed on patients with duplicated pelves as follows:

	<i>Cases</i>
Nephrectomy.....	15
Heminephrectomy (2 requiring complete nephrectomy later).....	4
Pelviolithotomy.....	6
Ureterolithotomy.....	3
Cutting of anomalous blood vessels to relieve hydronephrosis.....	1
Ligation of aberrant (upper) ureter opening into the vagina.....	1

The surgical treatment of pathologic complications, other than lithiasis, which affect the double kidney will, in the majority of cases, be radical, necessitating nephrectomy. Although infection, particularly if it is chronic, may be largely confined to the primary segment, it usually will invade the other segment to such an extent that nephrectomy is advisable. Conservative operation is permissible only in the presence of lithiasis, early localized infection other than tuberculosis, or small hydrone-

phrosis confined to one segment. Nephrolithotomy or pelvolithotomy offers no greater technical difficulties in the double kidney than in the normal. A small stone in the pelvis, however, may be easily overlooked unless the duplication is recognized. In 1 case in our series, ligation of an anomalous renal blood vessel which constricted one of the ureters was sufficient permanently to remove obstruction to urinary drainage. In the case in which an aberrant ureter ended in the vagina the secretion from one segment was markedly diminished. The ureter was ligated and the patient had no complications other than the usual reaction following ligation. This would suggest the possibility of treating hydronephrosis in the double kidney, when not too extensive or infected, by merely ligating the ureter of the affected segment.

Heminephrectomy

Resection of the diseased segment of a double kidney, on first thought, seems to be a formidable procedure. When conditions are favorable, however, it offers no great technical difficulties and is followed by favorable results. Owing to the fact that opportunities for the operation are limited and the anatomic conditions are often not recognized, heminephrectomy has seldom been performed in the past. If there is considerable pyelonephritis in the resected segment, infection often spreads to the remaining portion after heminephrectomy, the urine which may have been normal prior to the first operation becomes infected, and subsequent nephrectomy is necessary.

Heminephrectomy has been reported as successful by Albarran, Le Dentu, Lennander, Pawloff, Mayo, Rumpel, Young, and Herrick. Albarran reported a case of a double kidney on the left side in which there was a thin isthmus of connecting tissue. The lower segment was normal; the upper segment was pyonephrotic and was successfully resected. Le Dentu resected an upper segment which contained a small dilated pelvis; although the lower segment appeared to be fibrous and showed chronic nephritis, it was allowed to remain. A fistula persisted for four months. Lennander resected a lower segment which he described as being pyonephrotic. Pawloff described the resection

of one segment for hydronephrosis. Young resected an upper segment which was atrophic and contained a branched stone.

In 2 cases in this series (cases 3 and 4) primary heminephrectomy was performed, but evidence of renal infection and persistence of symptoms made it necessary to perform a secondary nephrectomy; at the time of primary operation the remaining segment had appeared to be normal. In case 3 the urine collected from the segment prior to operation was normal and the phenolsulphonephthalein excretion 8 per cent in fifteen minutes. Heminephrectomy had been performed because of a small infected hydronephrosis and stone in the lower segment with apparently successful results. Within a few months, the patient had dull pain referred to the affected kidney and other evidences of renal infection. Seven months after operation catheterization of the remaining segment showed marked renal infection; only a trace of phenolsulphonephthalein was returned in fifteen minutes. Nephrectomy of the remaining segment was performed, and examination showed diffuse pyelonephritis with atrophy. It is evident that heminephrectomy should not be attempted unless the pathologic condition is confined entirely to one segment and clinical evidence shows definitely that the remaining segment is normal and functioning. Even under such favorable circumstances infection may invade the remaining segment, necessitating a secondary operation. With proper suturing the post-operative hemorrhage should be negligible. If infection remains in the tissues, however, a sinus may persist indefinitely and reopen at intervals. The healing process resulting after heminephrectomy was clearly shown in the segment of a double kidney which was subsequently removed. The resected surface, though pitted in some areas, was smooth and had assumed the normal rounded contour of one of the renal poles. The pathologic process had involved only the tissues immediately adjacent to the line of incision. There was moderate lymphocytic infiltration, in some areas caused by absorbed suture materials. The glomeruli were somewhat clumped and the destruction of interglomerular tissue was greater than that of glomeruli. There was only slight fibrosis and hyalinization of the glomeruli, and

many immediately adjacent to the line of incision were apparently normal. Factors rendering operation easier and favorably influencing the results are first, considerable distance separating the two pelves; second, definite division of the two segments by a cicatricial band, and definite confinement of the disease to one segment, and third, chronic and cicatricial nature of the pathologic lesion.

Hydronephrosis

The most common lesion requiring surgical treatment is hydronephrosis caused, usually, by the obstruction of one ureter. Whether this occurs at the point where the ureters cross one another and is the result of this crossing, as suggested by Pawloff, has not been definitely proved. It seems probable however, that in some cases the ureteral obstruction is the result of stricture due to congenital anatomic defect. In several of the cases herein reported stricture in the lower ureter was associated with marked dilatation of the ureter above, comparatively little dilatation of the renal pelvis itself, and marked cicatricial pyelonephritis in the peripelvic renal tissue. In cases of large hydronephrosis the surrounding tissues usually become involved and atrophied and the infection may spread to the other renal segment.

Tuberculosis

In 6 cases of group 1 nephrectomy was performed for tuberculosis. In 4 the disease was largely confined to the lower segment. In each case a distinct cicatricial band separated the two segments, which evidently represented nature's determined effort to confine the disease to the segment in which it originated. If partial resection of the kidney for a localized area of tuberculosis could ever be considered, no more favorable opportunity could be discovered. However, microscopic examination of every such kidney removed showed that isolated tubercles and giant cells had invaded the apparently normal tissue adjacent to the area of tuberculosis.

Chronic tuberculosis confined to one pole of a single kidney, if caseated or fibrous and walled off from the remaining apparently normal renal tissue, may easily be confused with tuberculosis involving one segment of a double kidney. The pelvis of the diseased segment may be obliterated and the ureter be atrophied or involved in localized perirenal adhesions and thus difficult to identify. The original pelvic duplication of the kidney doubtless has been occasionally overlooked.

Atrophic pyelonephritis

The atrophic or cicatricial form of pyelonephritis is of comparatively common occurrence and may offer unusual difficulty in clinical diagnosis. Although the process may be confined largely to one segment, the other is often also involved so that in most cases nephrectomy is necessary. In the pyelogram the usual, small, abbreviated pelvis of the upper segment of a normal double kidney may be confused with the contracted pelvis usually observed in atrophic pyelonephritis in the single kidney. A differential phenolsulphonephthalein estimate should establish the diagnosis, since in atrophic pyelonephritis return of the dye is greatly reduced, varying from a trace to 1 or 2 per cent in fifteen minutes; in a duplicated pelvis the return is generally at least 6 or 8 per cent.

HEMINEPHRECTOMY: FOUR CASES

Case 1 (A308528). Miss K. M., aged twenty-seven years, came to the Clinic because of frequent short attacks of pain on the right side. For the last three years pain at times had become very severe, and discomfort had been almost constant. Appendectomy had been performed, but the character of the pain remained unchanged.

The physical examination was negative. The urine contained a few pus cells, and the two-hour return of phenolsulphonephthalein was normal. Roentgen-ray examination revealed a branched irregular shadow in the renal area. At cystoscopic examination the bladder, urine, and ureters were found to be normal. Phenolsulphonephthalein return in fifteen minutes was 12 per cent from the left ureter and 5 per cent from the right. A pyelogram revealed a double pelvis on the right; the branched irregular shadow was obscured in the lower pelvis.

A diagnosis of a double right kidney with multiple stones in the lower pelvis was made.

At operation a moderately enlarged kidney was found with two pelves and two ureters which united 2 cm. below the two pelves. The lower pelvis was small and contracted and contained several stones. The ureter of this portion was dilated and obstructed by a small stone which had lodged at the point of juncture with the upper ureter. The lower segment of the kidney, which was demarcated from the upper by a deep groove, was dissected free at the juncture of the middle and lower thirds. As each portion had a separate blood supply, the artery and vein to the lower portion were ligated and cut. The ureter was excised close to its juncture with the upper segment and removed with the lower segment of the kidney. The line of incision on the remaining renal segment was sutured and covered with a fatty fascial flap. The portion of the kidney removed contained a branched stone, several small stones, and several cortical abscesses with small stones. Post-operative recovery was rapid; several times a small sinus at the lowest angle of the incision drained a few drops of pus and then closed. Eighteen months later, the patient was perfectly well.

Case 2 (A57428). Mrs. M. C. T., aged thirty-two years, came to the Clinic because of a general sense of discomfort in the right side of the abdomen of seven years' duration. Four weeks before, abdominal discomfort had increased.

Physical examination was negative except for a palpable right kidney. Urinalysis and the roentgen-ray examinations were negative. Cystoscopic examination revealed complete duplication of the right ureter. Right pyelograms revealed a stricture of the inner ureter near the bladder wall with a hydro-ureter above. The pelvis connecting with this ureter was apparently not dilated; the lower pelvis and ureter were normal. A diagnosis was made of double kidney and ureter with a hydro-ureter draining the cephalad segment.

At operation a double right kidney was found with complete duplication of the ureter and pelvis. The ureter draining the upper pelvis was dilated to the size of the small intestine down to a strictured point near the bladder. Each half of the kidney had its own blood vessels. The ureter and blood vessels to the upper portion were ligated and the upper half of the kidney resected. The ureter was dissected to 2 cm. above the bladder where it was ligated and cut. The remaining section of the kidney was sutured with catgut. The patient's recovery was unevent-

ful and, one year later, she was much improved, although she had pain occasionally in the right side.

Case 3 (A59781). Mr. H. S. H., aged forty-five years, came to the Clinic with attacks of pyuria associated with chills and fever. Seven years before, he had had a short spell of hematuria and had passed a small stone. For the last three years, he had had intermittent attacks of left abdominal pain.

Physical examination revealed tenderness in the left loin. The urine contained pus and blood. The roentgenogram contained a shadow in the left renal area. Cystoscopic examination revealed two adjacent ureteral openings on each side near the usual site in the trigone. On the left side the upper opening was dilated and exuded cloudy fluid; the urine from the lower was normal. A roentgenogram taken after the insertion of four lead catheters showed complete bilateral duplication; the pyelogram taken on the right side showed that the upper and lower pelves were connected by a common calyx. A left pyelogram made through the infected ureter revealed a dilated pelvis which accounted for the shadow in this area. The diagnosis was complete bilateral duplication of the ureters and pelves with calculous pyonephrosis in the lower segment of the left kidney.

At operation a double kidney with two ureters and two pelves was found; the lower pelvis was dilated and soft; it contained a stone and a small papilloma, probably a result of irritation. There was a definite line of demarcation between the two portions of the kidney; both segments had a separate blood supply. The ureter and blood vessels to the lower half were tied and cut and the lower portion of the kidney was resected. The patient recovered from the operation rapidly.

Seven months after the first operation, the patient returned complaining of almost constant pain in the region of the left kidney. The function from the right side was normal, that from the left, very slight. At a second operation the remaining portion of the kidney was removed. This portion of the kidney was apparently normal, except for moderate thickening and fibrosis of the renal pelvis. The area from which the pelvis had been removed at the previous operation was smooth, well healed, and without adhesions. Eleven years later, the patient had no trouble attributable to his renal condition.

Case 4 (A232839). Mrs. B. S. P., aged forty-one years, came to the Clinic because of hydronephrosis. Two years before, she had

had an attack of hematuria of two weeks' duration. Since then she had had several attacks of fever, chills, and pain in the left kidney area, associated with frequency.

The physical examination was negative. The urine contained pus cells but no bacilli of tuberculosis. The roentgenogram showed multiple shadows in the left renal area. On cystoscopic examination bilateral ureteral duplication was found; two ureters opened on the right of the trigone and two on the left. The phenolsulphonephthalein return from the left upper ureter was 10 per cent in fifteen minutes; from the lower, zero. A pyelogram after injection of both of the left ureters revealed complete duplication of pelvis and ureter; the multiple shadows seen in the roentgenogram of the kidney were confined to the lower pelvis. The diagnosis was complete, bilateral duplication with hydronephrosis and stones in the lower left renal segment.

At operation a double left kidney was found; the lower portion consisted of a hydronephrotic sac 12 cm. in diameter and containing several stones. The hydronephrosis was caused apparently by kinking of the ureter by an anomalous blood vessel; the stones were secondary to the dilatation and infection. The sac was dissected out and the lower part of the kidney amputated; the upper two-fifths with the small pelvis and ureter were left intact. The cut surface was sutured with catgut. Following the operation the patient had a constantly high temperature and the wound drained freely. One month later, the wound was reopened and the remaining portion of the kidney was removed; it contained a moderate amount of normal tissue, but gave evidence of chronic infectious nephritis. The patient improved rapidly and, three years later, was in good health.

NEPHRECTOMY FOR HYDRONEPHROSIS: SIX CASES

Case 5 (A81801). M. D., a baby girl aged nine months, was brought to the Clinic on account of abdominal cramps and fever of four weeks' duration.

The baby looked septic and on examination a movable tender mass was found in the left side of the abdomen.

On exploration the left kidney was found to be about twice the size of a normal adult kidney; double ureters were fused just above the bladder at a point where distinct narrowing was made out. The common ureter was divided above the bladder and removed with the renal mass. The kidney was composed of two greatly dilated and thickened pelves separated from one another by a thin layer of renal tissue; the

minor calices were obliterated. There was almost complete obliteration of the renal tissue (fig. 10). One year later, the child was in excellent health.

Case 6 (A151528). Mrs. B. C., aged fifty-two years, came to the Clinic complaining that she had been feeling weak and run down since her last confinement, sixteen years before. For the last four months she had had a dull pain in her back and frequency of micturition.

The urine contained pus cells. The roentgenogram contained a small shadow in the region of the left kidney. On cystoscopic examination an impassable obstruction was found in the left ureter 20 cm. from the bladder. The urine from the left side contained pus; from the right the urine was normal. The phenolsulphonephthalein return from the left kidney was 1 per cent in fifteen minutes. A diagnosis of left pyonephrosis was made.

At operation a double kidney was removed. Both pelves were dilated. The ureters connecting the two pelves united 3 cm. below. They were almost completely obstructed at the juncture by a small stone which accounted for the shadow seen in the original roentgenogram. There was only moderate destruction of the renal parenchyma. The upper segment was smaller than the lower and its pelvis was markedly dilated and thickened; the lower pelvis was only slightly increased in size, but showed moderate fibrosis. The patient's convalescence was uneventful, and two months later, she was in good health.

Case 7 (A193971). Mrs. C. D., aged thirty-four years, came to the Clinic complaining of attacks of right abdominal colic associated with chills, fever, and pyuria, beginning eight years before, after childbirth, and lasting about two years. During the last six years pain had been intermittent in the upper right abdominal quadrant. Her gallbladder had been explored, but it had been found normal.

On physical examination a tender mass was palpated in the upper right quadrant. The roentgenogram and examination of the urine were negative. Cystoscopic examination revealed a normal bladder with normal appearing urine from both sides. The phenolsulphonephthalein return was 12.5 per cent from the left ureter in fifteen minutes and 7.5 per cent from the right. A pyelogram of the right kidney revealed duplication of the pelvis and ureter with hydronephrosis and hydro-ureter. A diagnosis of right hydronephrosis in a double kidney was made.

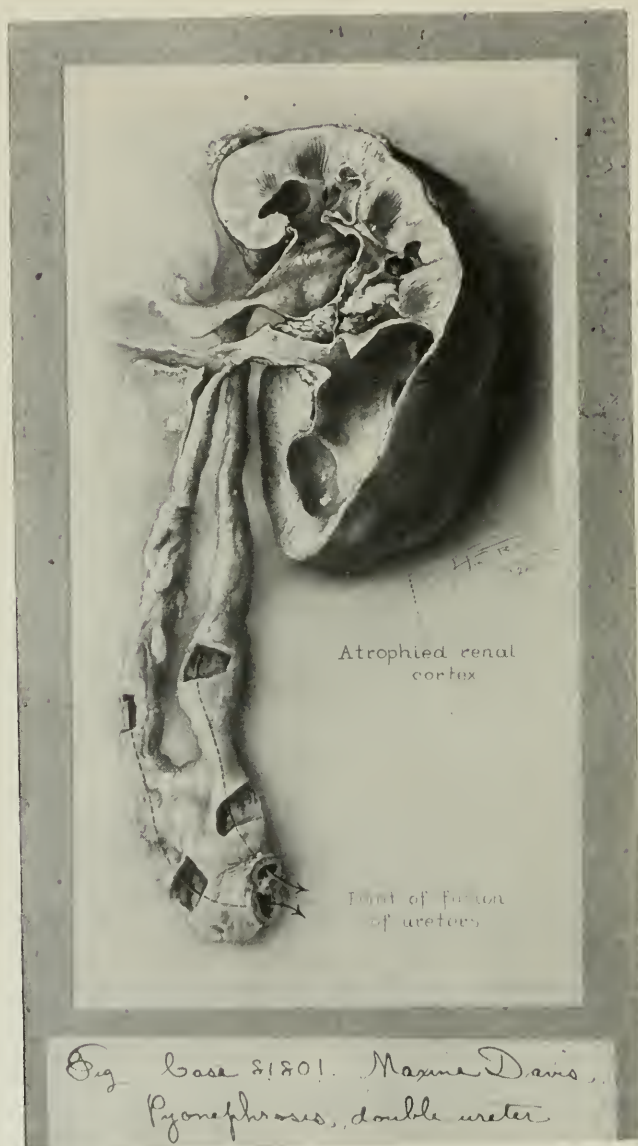


FIG. 10. CASE AS1801

Extensive hydronephrosis of both segments of a double kidney. The ureters are fused at the ureterovesical juncture.

At operation the right kidney was removed. A double pelvis and ureter were found; the upper ureter was markedly dilated. Both ureters were excised about 8 cm. from the kidney, but the point of bifurcation was not found. The upper part of the kidney was almost completely destroyed, the lower contained little normal tissue and much interstitial fibrosis. The patient recovered from the operation readily.

Case 8 (A234432). Mr. R. R. P., aged forty-six years, came to the Clinic because of intermittent periods of hematuria of five years' duration. For several months, he had had moderate pain in his left knee and ankle and a sense of discomfort in the region of the right kidney.

The physical examination was negative; the urine contained pus cells and blood. A roentgenogram contained multiple shadows in the right kidney area. Cystoscopic examination revealed a normal bladder. The urina from the right ureter contained a small amount of pus; that from the left was normal. The phenolsulphonephthalein return was 10 per cent from the right ureter in fifteen minutes, and 12 per cent from the left. A pyelogram of the right kidney revealed duplication of the pelvis and ureter; the calices of the lower pelvis were dilated, which obscured the shadows seen in the original roentgenogram. A diagnosis of stones in a right double kidney was made.

At operation a double kidney almost completely divided by a lateral sulcus was found. The ureters draining the two pelves united about 3 cm. below the lower pelvis. A small papillary cystadenoma was enucleated from the renal cortex and two small stones were removed from the lower pelvis.

Six months later, the patient returned to the Clinic. He had gained 15 pounds and had no urinary complaint, but he had a constant dull pain in his lower right quadrant. The roentgenogram contained a shadow in the region of the right kidney. Cystoscopy and pyelography located the stone in the lower pelvis. Both the upper and lower pelves showed moderate inflammatory dilatation.

At the second operation the right kidney was removed. Both pelves contained evidences of chronic infection and the lower ureter was dilated and thickened. Many fine cortical abscesses were scattered throughout both portions of the kidney (fig. 11). Three years later, the patient was perfectly well, although at times he had slight pain in the lower abdomen.

Case 9 (A308206). Mr. A. K., aged forty-five years, came to the Clinic on account of numerous attacks of left renal colic and almost

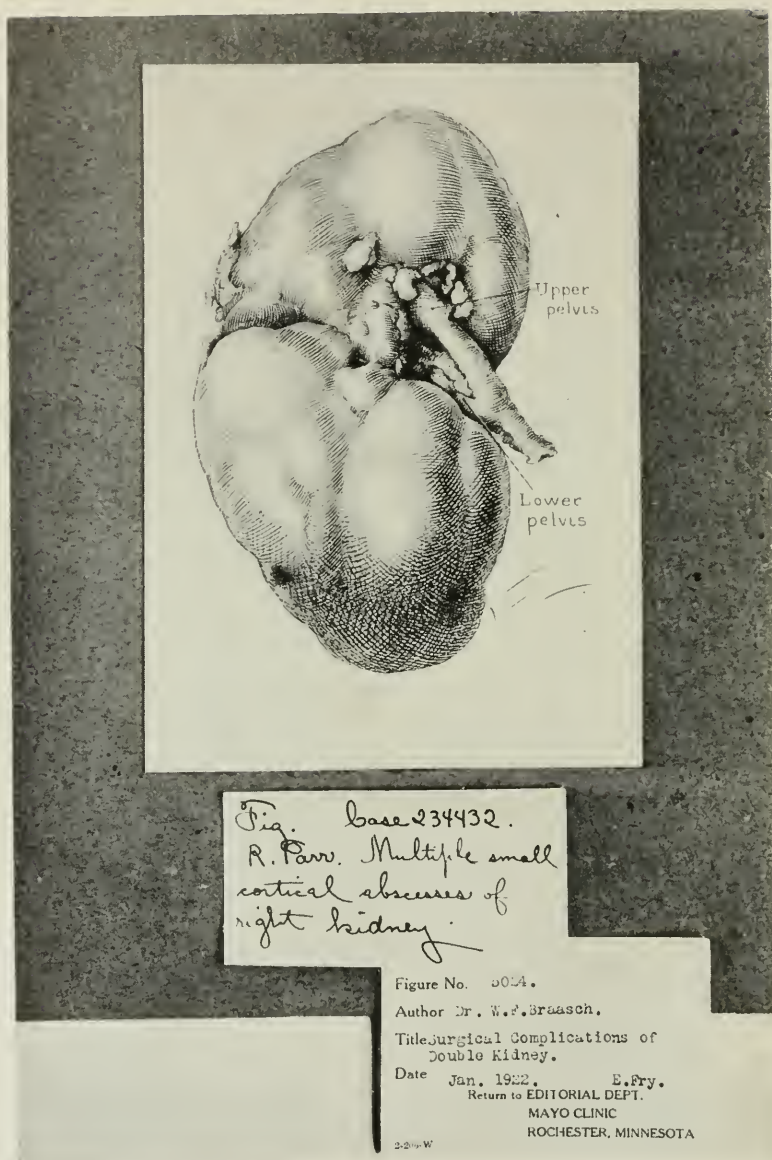


FIG. 11. CASE A234432

Double kidney with dilated infected lower segment, containing many cortical abscesses. The upper and lower segments are separated from one another by a deep cleft.

constant dull heavy pain in the left lower abdomen during the last seven years.

The general examination was negative. The urine contained a moderate amount of pus and red blood cells. The roentgenogram contained a shadow opposite the third lumbar vertebra. At cystoscopic examination clear spurts of urine were seen coming from both ureters. The differential functional test was 15 per cent return of the dye from the right side and 7 per cent from the left. A left pyelogram revealed a dilated ureter and a large hydronephrosis, which obscured the shadow opposite the third lumbar vertebra. A diagnosis of left hydronephrosis with stone was made.

At operation a large kidney with two moderately dilated pelves was found on the left; the upper and larger was drained by a greatly distended ureter. Both left ureters opened into a markedly sacculated pouch, which extended from the juncture 3 cm. below the upper pelvis towards the bladder for a distance of 7 cm. A small stone was found impacted in the lower end of the sacculatation, blocking the common outlet (figs. 12 and 13). Two years later, the patient was in good health, having had no further trouble.

Case 10 (A376487). Miss M. J., aged thirty-two years, came to the Clinic because of attacks of dull pain referred to the left upper abdominal quadrant and radiating to the lower quadrant; she had had attacks for four years, a severe one a year and a half before. Recently the attacks had occurred every eight to ten days, or they lasted from twelve to twenty-four hours and were followed by a dull ache in the anterior part of the abdomen, often with flatulence and distress over the entire lower abdomen. Frequency was moderate. It will be noted that the pain was entirely anterior and not at all suggestive of renal involvement.

The urinalysis was practically negative. The phenolsulphonephthalein return was 50 per cent in two hours and fifteen minutes. Roentgenograms of the urinary tract, colon, and stomach were negative. A cystoscopic examination was made for the purpose of identifying the pain. Both ureteral orifices were normal in location and appearance, and secretion of the right kidney was normal. A catheter introduced into the left ureter did not meet obstruction. One hundred ten cubic centimeters of residual urine was withdrawn from the renal pelvis; there was only a faint trace of phenolsulphonephthalein in fifteen minutes. A pyelogram of the left kidney showed definite dilatation of

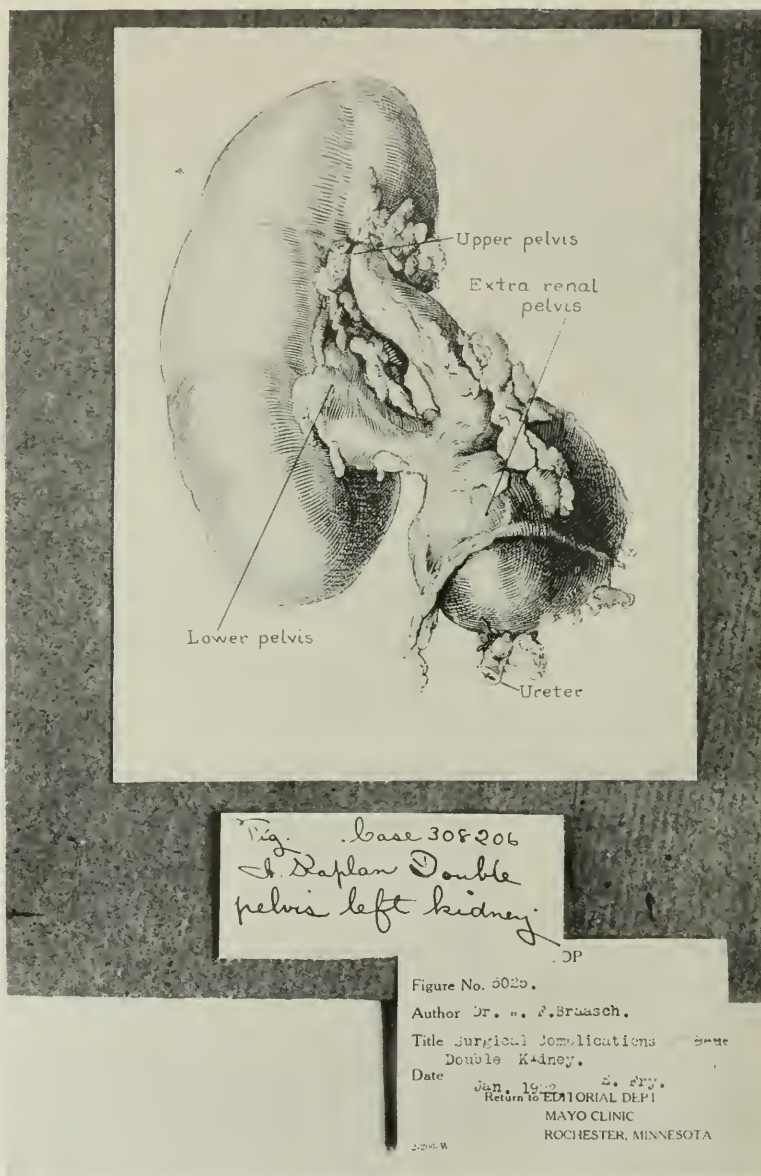


FIG. 12. CASE A308206

Primary division of the ureter or pelvis situated away from the kidney and attached to it by elongated ureteral divisions. Each division drains a separate renal segment.

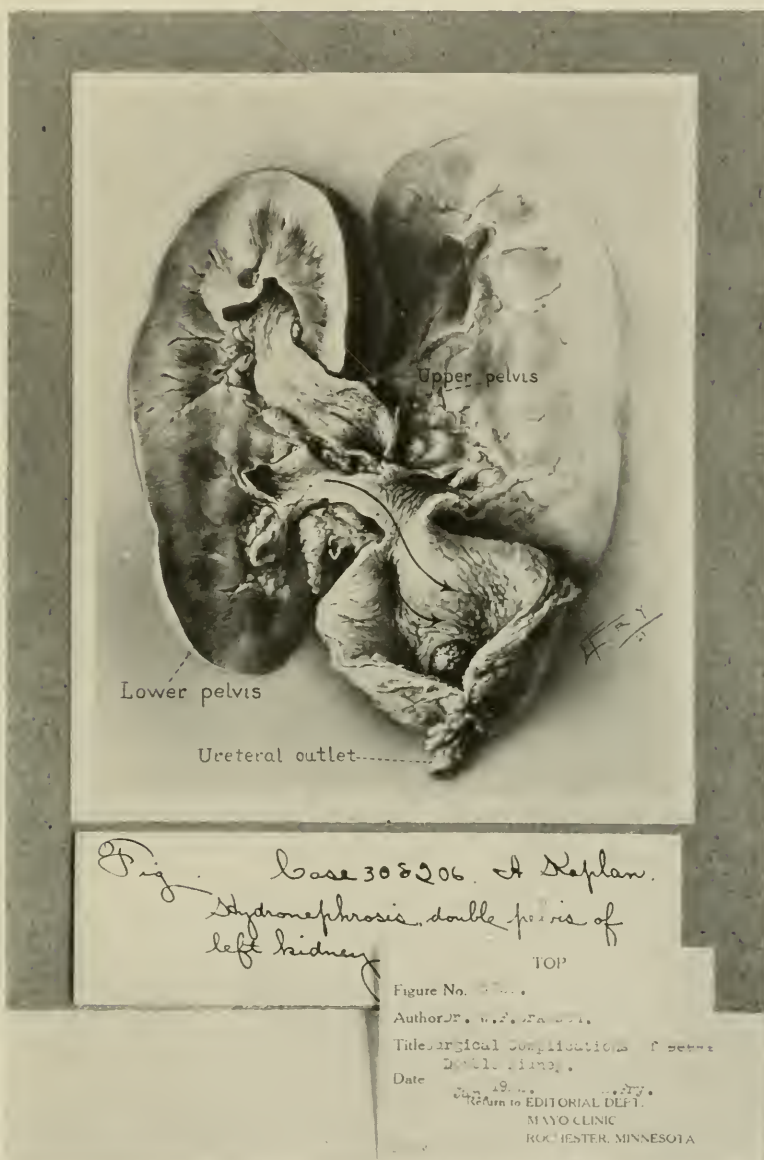


FIG. 13. CASE A308206

Section of double kidney showing extrarenal pelvis blocked at its outlet by a stone.

pelvis and calices. The dilatation, however, did not appear sufficiently marked to account for the large amount of residual urine found in the renal pelvis, which we were at a loss to explain. A diagnosis of left hydronephrosis was evident.

At operation the renal pelvis was found to be markedly dilated. The kidney tissue was evidently largely destroyed, and a nephrectomy was performed. On section of the kidney two definite segments of the renal pelvis were found, the upper of which was confined within the kidney proper; the dilated portion visible outside the kidney was directly related to the lower segment only. The two segments of the pelvis were separated by a definite band of atrophied renal tissue and were connected by a narrow isthmus which corresponded to two adjacent calices which had coalesced. The calices were markedly dilated in both pelves. Only a narrow rim of cortical tissue remained which appeared to be atrophic. The patient had a normal convalescence and two months later was in good health.

NEPHRECTOMY FOR TUBERCULOSIS: SIX CASES

Case 11 (A81845). Mr. R. F. R., aged thirty-seven years, came to the Clinic because of frequency, dysuria, and occasional attacks of moderate pain in the left renal area for the last two years. He had had both testicles removed for tuberculosis seven years before.

The left abdominal wall was rigid. The roentgenogram was negative. The urine contained pus cells and bacilli of tuberculosis. Cytoscopic examination revealed only slight cystitis. Normal urine was obtained from the right ureter; the opening of the left would not admit a catheter; the site was marked by a small area of granulation. A diagnosis of occluded left renal tuberculosis was made.

At operation a double kidney about twice the normal size was removed. There were two pelves and two ureters; both ureters were dilated and thickened. There was a well defined sulcus dividing the upper portion of the kidney from the lower. Bifurcation of the ureters was not found. The lower kidney and pelvis composed only about one-fourth of the entire mass. The pelvis was thickened and contracted and the surrounding renal tissue was almost completely destroyed by an extensive tuberculous caseation. A band of solid renal tissue 3 cm. wide separated the two pelves. The upper pelvis was slightly dilated; the cortex of this portion contained a few small areas of tuberculosis. Six months later, the patient was in good health.

Case 12 (A219577). Mrs. H. B., aged twenty-five years, came to the Clinic complaining of a dull ache in her back of two years' duration. Two weeks before, she had noticed blood in the urine; this had been increasing. Several days after the onset of the bleeding she had developed a severe cramp-like pain in the region of the left kidney.

At examination the left side of the abdomen was found to be tender; the glands in the cervical region were enlarged. The urine contained both pus and blood but no bacilli of tuberculosis. The roentgenogram showed several small shadows in the region of the left kidney. Cystoscopic examination revealed a normal bladder. The urine from the left ureter contained blood; that from the right was normal. The phenolsulphonephthalein return was 12 per cent from the right ureter in fifteen minutes and 10 per cent from the left. A left pyelogram revealed duplication of the pelvis; the shadows observed in the original roentgenogram were included in the lower pelvis where there was also evidence of tissue necrosis. A diagnosis of left double kidney with infection and stones in the lower pelvis was made.

A left nephrectomy was performed. The two pelves of a double kidney were found to be separated from one another by a heavy band of renal tissue; a deep groove externally marked the division. The lower pelvis was small and contracted and showed extensive tuberculous caseation; a thickened edematous ureter drained it. The shadows seen in the roentgenogram and thought to be stones were caused by calcareous deposits in the centers of these areas of tuberculous caseation. The upper, smaller, and apparently normal portion of the kidney emptied into the lower portion through a narrow tapering connection. The patient recovered from the operation and is now well.

Case 13 (A299002). Mr. C. A. T., aged thirty-three years, came to the Clinic because of indefinite pain in the lower abdomen of two years duration. Appendectomy had been performed without relief. During the last year, he had had moderate pain in the left loin, especially noticeable after exertion or when riding horseback. He had not had urinary symptoms, although for several months there had been pus in the urine. Ten days before, while riding horseback, he had bruised his left testicle.

The physical examination was negative except for the finding of an enlarged nodular urine-stained left epididymis. The urine contained a large amount of pus and bacilli of tuberculosis. Cystoscopic examination revealed a moderate degree of cystitis; clear urine was obtained

from the right ureter and cloudy from the left. The phenolsulphonephthalein return was 22 per cent from the right ureter in fifteen minutes and 2 per cent from the left. A pyelogram of the left kidney revealed a few scattered areas of dilated calices and evidence of tissue necrosis. A diagnosis of left renal tuberculosis was made.

At operation a kidney twice the normal size was removed. Two thickened dilated ureters drained separate pelves and joined each other about 2 cm. below the lower pelvis. On section extensive caseating tuberculosis of both sections of the kidney was found. The pelves were of about equal size and were divided by a band of parenchymatous tissue 1 cm. wide (Fig. 14). Three weeks later, the left epididymis was removed and found to be tuberculous. The patient's convalescence was uneventful and he left the hospital in good condition.

Case 14 (A339574). Mrs. H. E. C., aged fifty years, came to the Clinic because of frequency and dysuria and occasional lower abdominal pain of three years' duration.

The physical examination was negative. The urine contained a moderate amount of pus and bacilli of tuberculosis. Roentgenogram of the kidneys showed a few calcified flakes in the right renal area. On cystoscopic examination ureteral cystitis of moderate degree was found. The inner of the two ureteral openings on the left side was apparently normal; the upper was contracted and eroded and emitted only an occasional spurt of turbid urine. The ureter and kidney on the right were both normal. On catheterization of the two left ureters a stricture was encountered in the outer ureter 10 cm. from the opening. The phenolsulphonephthalein return was 6 per cent from the inner ureter in fifteen minutes and 1 per cent from the outer. Pyelograms of the left kidney revealed a double pelvis; the upper connected with the lower. The lower pelvis injected through the outer catheter possessed only a few dilated calices and a distended ureter. A diagnosis of duplication of the left kidney with tuberculosis of the lower segment was made.

At operation a long, thin, tapering kidney with a definite line of division on the anterior surface was removed. There were two pelves and two ureters. The segment between the two pelves showed extensive tuberculous caseation which extended to and almost completely destroyed the lower pelvis. The upper renal segment was normal in appearance but a histologic examination revealed few isolated tubercles in the renal cortex. The patient convalesced normally and, two years later, was perfectly well.

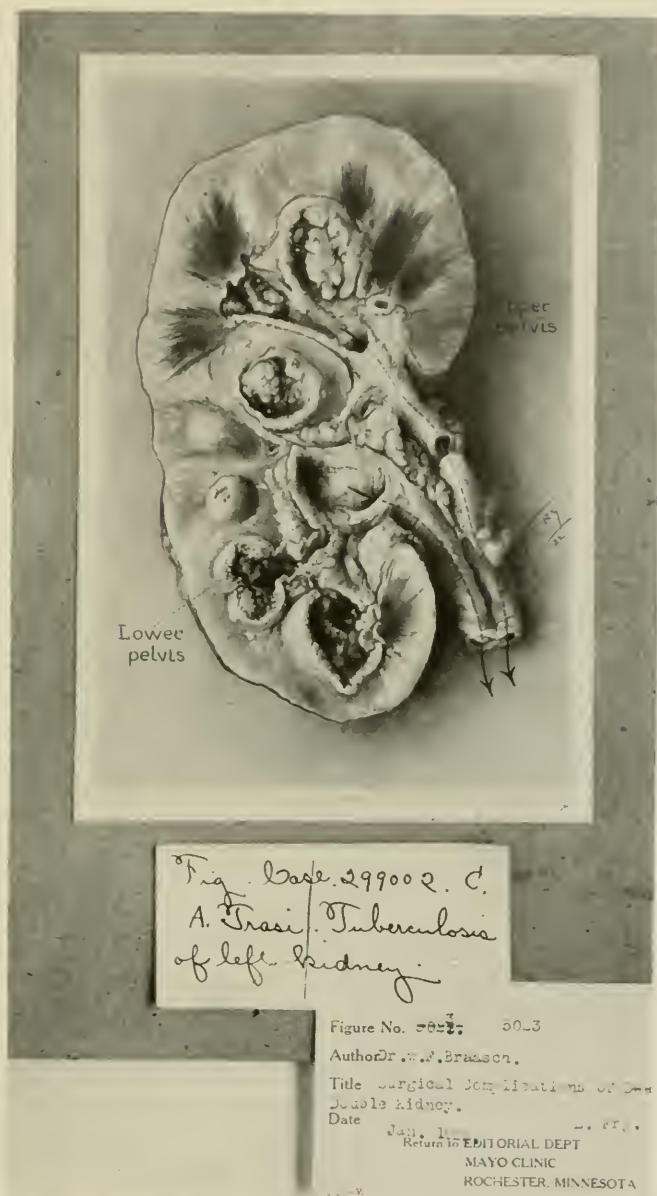


FIG. 14. CASE A299002

Extensive caseating tuberculosis involving both segments of a double kidney

Case 15 (A342668). Mrs. B. M., aged thirty years, came to the Clinic with urinary frequency at intervals, which had begun eleven years before, and pain referred to the neck of the bladder. For two years the patient had had occasional dull pain referred to the left kidney area, but this had improved during the past year. She had had occasional spells of epigastric distress. The general condition was suggestive of neurosis. There was no loss in weight.

General physical examination including roentgenograms of the urinary tract and chest, was negative. A specimen of urine catheterized from the bladder contained only 20 pus cells in a high power field of the microscope. The sediment was stained for the bacilli of tuberculosis and was negative. The phenolsulphonephthalein return was 50 per cent in two hours and fifteen minutes. Cystoscopic examination revealed a bladder with normal capacity, and save for a few areas of slight inflammation, comparatively normal. The left ureteral opening was slightly eroded, with an inflated area of mucosa and granulation tissue around it. Obstruction was met by the catheter introduced into the left ureter at a distance of 2 cm. from the opening, but at a subsequent examination the catheter passed into the ureter to a normal length without obstruction. Catheterized specimens obtained at the second examination from both right and left kidneys were normal. A pyelogram of the left side showed a very small pelvis with abbreviated calices. The ureter was but slightly dilated for a distance of several centimeters. Below this it was markedly dilated. A diagnosis was made of duplication of the pelvis and ureter with destruction of the lower pelvis (?), atrophic pyelonephritis (?), and tuberculosis of the left kidney (?).

At operation a double kidney with duplication of the pelvis and ureter was apparent. The lower pole of the kidney was atrophic and cicatricial. The two parts of the kidney seemed quite distinct, with a definite zone of demarcation. It was thought at first that the lower portion was atrophic as the result of cicatricial pyelonephritis, since no definite evidence of tuberculosis had so far been discovered. The lower portion was then resected without much difficulty. On microscopic section of the renal tissue at the line of excision, areas were found containing atypical tubercles and giant cells. The remaining portion of the kidney was then removed. The patient had an uneventful convalescence and left the hospital in good condition.

Case 16 (A377195). Mr. G. V. G., aged thirty-five years, came to the Clinic with symptoms beginning fifteen years before with slight

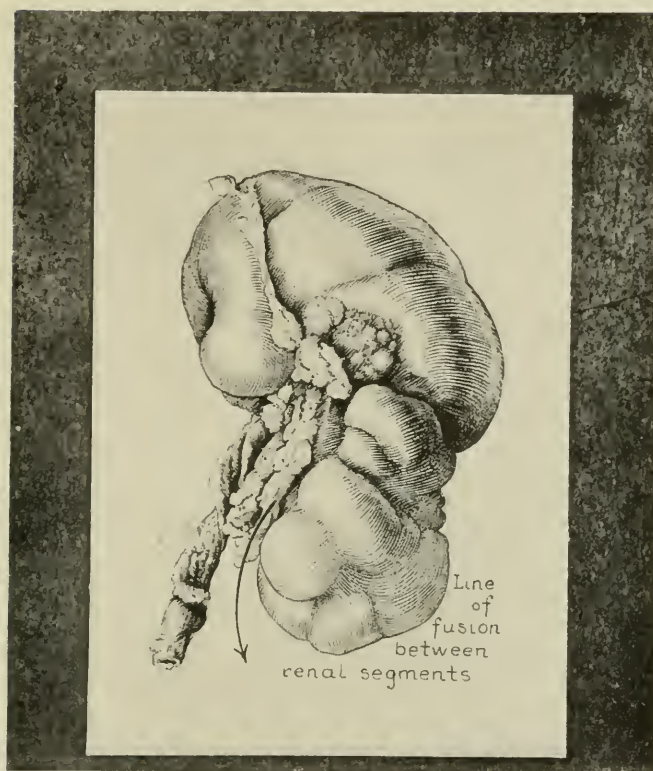
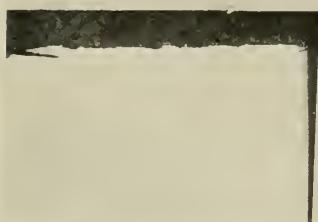


Fig. Case 377195. S. Dan Gorder,
Tuberculosis of right kidney.



TOP

Figure No. 5027.

Author Dr. W. F. Braasch.

Title Surgical Complications of Double Kidney.

Date Jan. 1922.

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FIG. 15. CASE A377195

Extensive tuberculosis of the lower segment of a double kidney. The two segments are almost completely separated from one another. The upper segment contains a few scattered tubercles and giant cells.

urinary frequency at irregular intervals. Seven years before, he had had a period of dysuria with increased frequency and very cloudy urine which had continued over a period of several months. Since then he had had diminished urinary disturbance with soreness and dull ache in the urethra. Five years before, he had noticed hard painless nodules in the left epididymis, and two years before, the same condition in the right epididymis. One year before, he had had slight hematuria.

The general examination was negative save for moderate chronic bilateral tuberculous epididymitis. The left lobe of the prostate was nodular. Roentgenograms of the urinary tract and chest were negative. A moderate amount of pus was found in the urine, and, after repeated stains, acid-fast bacilli were found. The phenolsulphonephthalein return was 50 per cent in two hours. Cystoscopic examination revealed a slight cystitis. The urine from both ureters appeared to be normal. A catheterized specimen of urine from the right kidney was normal; that from the left contained an occasional pus cell. The differential phenolsulphonephthalein test showed 20 per cent to be coming from the left kidney, and 7 per cent from the right in fifteen minutes. A pyelogram of the left side showed marked dilatation of the ureter; the pelvis and calices were abnormally small. A diagnosis was made of tuberculosis of the left kidney.

At operation a double kidney with tuberculosis in the lower segment was found. The upper portion of the kidney appeared to be normal, while the lower segment was very evidently diseased and functionless (fig. 15). Since the bacilli of tuberculosis had been found in the urine, a complete nephrectomy was performed. On section of the kidney a sharp line of demarcation between the healthy and diseased portions was noted. On microscopic examination of the apparently normal tissues, however, several areas of encroaching foci of tuberculosis were observed. The patient had a normal convalescence and left the hospital in good condition.

NEPHRECTOMY FOR ATROPHIC PYELONEPHRITIS: THREE CASES

Case 17 (A188815). Mr. H. K. E., aged twenty-six years, came to the Clinic because of pain in the left renal area of sixteen years duration. The pain had been most noticeable during micturition. During the last three years, he had had several attacks of left renal colic accompanied by frequency and pyuria.

Physical examination was negative except for the finding of tenderness in the upper left quadrant of the abdomen. The urine contained pus cells and blood; the roentgenogram was negative. Cystoscopic examination revealed diffuse cystitis with pus cells and blood coming from the left ureteral opening. The phenolsulphonephthalein return was 20 per cent from the right ureter in fifteen minutes and 5 per cent from the left. A left pyelogram revealed inflammatory changes of the renal pelvis. A diagnosis of chronic pyelonephritis with atrophy was made.

At operation a small contracted kidney was removed. Two calices and two ureters were present; both ureters were markedly thickened. The kidney was divided by a deep sulcus into two distinct parts. The upper portion was almost completely destroyed, the surfaces of the dilated calices and pelves were necrosed. The pelvis of the lower half was thickened and contracted and the renal tissue had been replaced almost completely by fat and fibrous tissue. Atrophy of all the renal tissue was practically complete. The patient made a rapid recovery after operation and, one year later, was perfectly well.

Case 18 (A223011). Mrs. T. L. M., aged forty-seven years, came to the Clinic complaining of attacks of urinary frequency of five years duration. Occasionally she had felt dull pain in the region of the left kidney. Three years before, she had been told that the left kidney was infected; the left renal pelvis had been lavaged a number of times.

The physical examination was negative except for the finding of infected tonsils. The urine contained a small amount of pus and blood. On cystoscopic examination a mild cystitis was found; the urine from the right ureter was normal, that from the left contained pus cells. The phenolsulphonephthalein return was 25 per cent from the right ureter in fifteen minutes and 1 per cent from the left. A pyelogram of the left kidney revealed a small contracted pelvis. A diagnosis of left atrophic pyelonephritis was made.

At operation a contracted septic kidney about one-half normal size, with two ureters, was removed. A line of division indented the anterior surface of the kidney between the upper and lower portions. Two distinct pelves, separated by a division of fibrous renal tissue, were thickened and contracted. The renal tissue in the lower segment was almost completely destroyed by fibrosis. The patient made a prompt recovery after the operation and was well four years later.

Case 19 (A308248). Mrs. C. I. W., aged thirty years, came to the Clinic because of frequency and dysuria. For six months, she had been feeling listless and run down. For six weeks, she had had severe pain in the left lumbar region radiating to the left groin with spells of frequency and dysuria and, on several occasions, chills and fever.

At physical examination an area in the left lumbar region was found to be tender. The temperature was 102. The urine contained a large amount of pus and the phenolsulphonephthalein return was normal. The roentgenogram contained an indefinite shadow in the area of the left kidney. At cystoscopic examination clear urine was seen coming from both sides. Phenolsulphonephthalein return in fifteen minutes was 17 per cent from the right ureter and 4 per cent from the left. A pyelogram of the left kidney revealed a small contracted pelvis. On account of the high temperature and tenderness over the left kidney a diagnosis of septic left kidney with atrophy was made.

At operation a kidney, normal in size, with two pelves and ureters was removed. The lower half of the kidney was studded with many small cortical abscesses. The pelvis draining this portion was dilated and almost completely filled with fat, which would account for the contracted appearance of the pyelogram. A slight sulcus on the anterior surface of the kidney divided the two portions. The ureteral juncture was not seen. The patient recovered readily from the operation and, twenty months later, was perfectly well.

SUMMARY

One hundred forty-four patients with duplication of the renal pelvis and ureter have been observed at the Mayo Clinic. The incidence of aberrant and bilateral duplications of ureters and pelves reported in the literature is relatively too high owing to the tendency to report the more unusual cases. Of the patients in this series the duplication was unilateral in 135 (94 per cent) and bilateral in 9 (6 per cent). Of the 135 patients with unilateral duplication 36 (25 per cent) had complete duplication and 99 (68.7 per cent) had incomplete duplication. Of the 9 patients with bilateral duplications 8 had complete duplication and 1 had incomplete.

Duplication may vary from duplication confined to the renal pelvis to duplicate pelves with separate ureters opening into the bladder. The pelves are generally unequal in size, the upper

being the smaller, and are separated by a bridge of normal renal cortex of variable extent. When an unusually small renal pelvis is outlined in the pyelogram, the possibility of duplication should be suspected.

Complete duplication will be discovered more often if a careful search is routinely made for anomaly at the time of cystoscopic inspection. In cases of partial duplication the diagnosis is made only by means of a pyelo-ureterogram.

The lower segment is primarily involved more often than the upper.

Hydronephrosis is the most common pathologic complication and is due to ureteral obstruction, generally in the region of the juncture of the two ureters in cases of incomplete duplication.

In tuberculosis of double kidneys gross evidence of the disease is generally confined to one segment, usually the lower; but in all cases histologic examination reveals tubercles in the intervening renal tissue and extending into the remaining segment.

Occasionally when only one pelvis is outlined by the pyelogram its unusual shape and contour may be misconstrued with pathologic changes occurring in one kidney, such as atrophic pyelonephritis.

In the series of 144 cases, the histories of 19 of which are here reported, 30 patients were treated surgically; 24 patients had definite pathologic conditions which did not require surgical treatment and in 27 evidence of disease was doubtful. Only 61 (42 per cent) of the patients were without pathologic complications and the anomaly was discovered in the examination for other conditions.

Fifteen of the 30 patients operated on submitted to primary nephrectomies and 4 to heminephrectomies, 2 of these later required complete nephrectomy. Six pyelolithotomies and 3 ureterolithotomies were performed. In 1 patient hydronephrosis was relieved by the cutting of an aberrant vessel and in another symptoms were relieved by the ligation of an aberrant ureter from the upper pole of a double kidney.

In the treatment of pathologic complications in a double kidney the indication for heminephrectomy is limited to but a

few favorable cases. The possibility of infection extending to the remaining half of the resected kidney, which may necessitate subsequent complete nephrectomy, must be considered.

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DISCUSSION

Dr. HUGH H. YOUNG, Baltimore: One of the difficulties which I have experienced with these cases of bifid ureter lies in the fact that the catheter is apt to pass by the point of bifurcation and urine is obtained from only one-half of the kidney, whichever branch of the ureter the catheter happens to pass into.

Several years ago I published a case of this character in which the X-ray, which had been previously taken, showed a large mass of stones in the right kidney and no stones on the left side. Ureteral catheter obtained purulent urine from the right side and practically clear urine from the left side. No pyelograms were taken. I naturally made a diagnosis of a normal kidney on the left side and advised operation. ('Phthaleins were not obtained because this was before the days of functional tests.) After operation, in which the stones from the right kidney were removed, the patient became uremic and died, and at autopsy we found a bifid ureter and double kidney on the left side, and in the upper half, which was situated so high that it did not show in the X-ray plate, I was amazed to find a large calculus surrounded by pus. The lower half of the kidney was normal and examination of the ureter showed that the ureteral catheter had passed into this lower half of the kidney rather than into the upper ureter which came off from the lower at a slight angle.¹

Since then it has been customary to withdraw the catheter while injecting the 'phthalein, so that in case there is a bifid ureter pyelograms of both pelves will be obtained. Following this technique there have been a good many cases of bifid ureter diagnosed and in one case a stone was found in the upper half of the kidney, which was then excised with the stone and upper branch of the ureter. In this operation I found that not only were the pelves and calyces quite separate and distinct but the

¹ For full report of case, see *Monatsb. f. Urol.*, 1903, viii, 591.

blood vascular system was just as distinct as the urinary system in the upper and lower halves of the kidney. By making the dissection through a somewhat fibrous line of demarcation which separated the two halves of the kidney, and which was shown by a furrow along the cortex, very little bleeding was encountered. The edges of the wound in the lower half of the kidney were then drawn together completely covering the raw area and stopping a hemorrhage.

These cases show the importance of pyelograms, which I believe should be done in a more routine manner than is usually the custom. Since we have gotten away from collargol and used thorium nitrate we have carried out pyelograms with great impunity even on both sides simultaneously, and by use of the gravity method of filling the pelves and care not to overdistend them painful reactions have been largely avoided.

I have been much interested in Dr. Furniss' report of cases of incontinence due to double ureters, one of which was external to the vesical sphincter. Undoubtedly this condition explains many cases of incontinence in women and occasionally in men.

Dr. ARTHUR L. CHUTE, Boston: I have little to add to what has been said. It is an extremely interesting subject. I think I described before this Society a number of years ago the case of a man whom I saw that was very puzzling. He was an Armenian who had been seen in many different countries at different times. The story, as I got it, was that this man had a urethral discharge that had continued for years after an infection. We could wash his bladder perfectly clear and then have him strain and he would pass pure pus. We traced this down to an opening of an abnormal ureter in the posterior urethra, which we removed together with this man's double pelvis kidney. He made a perfectly good recovery. The case had been very puzzling but we were able finally to work it out by exclusion, more than anything else.

Dr. Furniss and Dr. Braasch both stated that if there were two ureteral openings in the bladder, there were necessarily two ureters and kidney pelves. I do not think that always applies, though it is undoubtedly the rule; I think Dr. Braasch mentioned

one case where there was a fusion of the ureter above. I recently saw a case where two ureters opened into the bladder but came together 2 or 3 inches above the bladder; there was only one ureter above and one kidney pelvis.

Dr. JOHN R. CAULK, St. Louis: This is a very fascinating problem and I think we are all more and more interested in it. This symposium has brought out the three types, those that invert, those of insertion, of Dr. Furniss', and probably Dr. Laurie's has to do with caliber. I shall speak particularly of the anomalies of caliber. I recently had 2 cases that were quite interesting. These were enormous ureters without dilatation of the kidney pelvis and without perforation or disturbance of kidney function. You will remember Eisendrath's work in 1917, collecting the ureters or congenital strictures, when he found 66 or 67 cases. All of these strictures had associated with them either an enormous hydronephrosis with destruction of the kidney or complete atrophy of the kidney along with ureteral dilatation.

I want to show a couple of slides but these cases have none, or very little kidney involvement. The explanation is somewhat difficult. It may be that there is an incomplete obstruction from an intramural valve. We did not find any obstruction, any stricture, any ballooning, or anything to account for obstruction. Two or three catheters were easily passed. There may be a mild intramural valve, or there may be something that has to do with the developmental effect within the ureteral wall itself. The ureter in developing comes from the back part of the Wolffian duct as a bud, which comes much larger during the first few weeks, and later develops into tubes. At a later date the musculature begins to build up. It may be that there is a delay in the development and the large ureter is permitted to remain large.

Neither of these individuals showed any obstruction at all. The first slide shows an enormous ureter, unilateral, running up, to the first transverse process, and it held 10 ounces. This was a middle-aged woman with bladder symptoms alone, with occa-

sionally a little ache in the side. You can see how large the ureter is in the picture. It came up to the renal pelvis with practically no dilatation below. The calyces are a little larger than normal.

Another case seen just the other day had 8 or 9 ounces of urine and showed a large ureter running straight up. Here (indicating) is the pelvis of that ureter, and the function of the kidney is very good.

This last patient had the same condition on both sides and the first one was unilateral. I could put three catheters, a big catheter and two others in the opening. This (indicating) would give an impression of something outside of the bladder, but I dare say that it is intramural. After I had slit the ureteral orifice for over 1 cm., this individual whom I had seen for over a year and had repeatedly emptied her ureter but never could keep it empty, the next day this woman had her normal peristalsis and has been in good condition since.

I believe this is a developmental thing, and not an obstructive condition from the lower ureter, without changes in the pelvis.

Dr. A. E. GOLDSTEIN, Baltimore: This subject is very interesting from several viewpoints. One is that in the past year I have made it a routine, as one of the gentlemen suggested, to give indigocarmin in picking up double ureters. We have given every patient an indigocarmin injection before cystoscopy. In that way we have picked up 8 cases of double ureters.

Regarding Dr. Young's statement about pulling the catheter down, I have been practising that for the past year, that is withdrawing the catheter entirely after injecting sodium iodide solution or after the catheter has been withdrawn about 25 cm. Then the pyelogram is taken. I will show you some lantern slides of these cases. All of them had pathological conditions.

Dr. F. C. HERRICK, Cleveland: I want to place on record a case along the line of Dr. Furniss', an extraureteral opening. While in the army a man was brought into the hospital complaining of left abdominal pain extending up under the costal border.

There had been no movement of the bowels and enemas failed to get results. We considered the case one of intestinal obstruction. The urine showed nothing. We had no cystoscope and there was no indication for using it if we had had one. Rectal examination showed a tit-like projection sticking down from the left side of the rectum, about 2 inches long, about as large as a thumb, with a large base where it joined the side of the rectum. It was very distinct and with the finger against the tip we could invaginate it. It would not give an impulse on coughing. We considered it a hernia of the small gut through the side of the rectum, but there was no impulse on coughing so there was no credence to that belief and a diagnosis was made of intestinal obstruction. A left pararectal incision was made but there was nothing in the intestine. The posterior peritoneum was opened. The kidney was a sac and the ureter went down and was attached to the rectum. Just before reaching the rectum the ureter, which had been $1\frac{1}{2}$ inches in diameter became about the size of a slate pencil and was then attached to the rectum. The ureter was divided at this point, clamped and tied, although there was no lumen opening into the rectum. The ureter and sac were removed and showed a simple closed ureter, dilated up to the kidney.

I think this case is unique. I have not been able to find anything of the kind in the literature and cannot explain its attachment to the rectum.

The patient Dr. Braasch quoted which I had operated, with the double kidney resection for dilatation of the lower pelvis, is in good health and has had two children since. Since then I have seen another case that was also resected, but not with such good results. I think that was my own fault, and I will make a later report.

Dr. O. S. LOWSLEY, New York: I have recently had a case of giant stone due, I think, entirely to an intramural stricture. The first picture showed the stone, as you see. The pyelogram showed a dilated kidney pelvis on this side (indicating) with a big ureter and the lower portion of the ureter showed an enor-

mous giant ureter here (indicating). Here (indicating) is the strictured portion, there the intramural portion of the ureter, with the lower portion shown here. We operated on that man a week ago last Friday, taking out the kidney and the entire ureter, and he is doing nicely. The history was of eight years' duration and he evidently had had a lot of trouble, but his resistance was such that he could carry on.

We have had 8 of these cases in the last year, and half a dozen of reduplication of the ureter with double kidney pelvis. One case had joined just above the wall of the bladder. These cases are brought out through the practice of withdrawing the catheter. Here (indicating) is a double kidney with the pelves bilateral, and here they are joined with large ureters, infected. This shows the junction of the two kidney pelves on the same side.

Dr. HERMAN L. KRETSCHMER, Chicago: In regard to Dr. Laurie's cases of dilated ureteral orifice, we have been interested in these cases from the standpoint of etiology. I think to say they are congenital does not answer the question. We have seen 1 case in which no etiological factor could be determined. In a second case the young man had ureteral stricture, due secondarily to a spina bifida. This boy had a good deal of difficult urination and was obliged to strain a good deal and had an increase in his intravesical pressure and had dilated ureteral orifices. It seems to me some of these cases can be explained by increase of the intravesical pressure, obstruction if you will, or otherwise. It is well known that prostatics, if there is increased stricture, will have return of the urine up their ureters.

The doctor mentioned that he had a very small, contracted bladder. I think it would be interesting to find out what was the cause of this condition. I believe the young man had long continued intravesical pressure, which produced this condition above.

Dr. LEON HERMAN, Philadelphia: I would like to ask Dr. Braasch if he employs Garceau catheters in making the diagnosis.

In reference to Dr. Kretschmer's remarks, it seems possible to me that in some instances great dilatation of the ureters may occur as the result of ancient disease in the region of the ureteral sphincter. The latter being functionally destroyed permits of gradual dilatation of the ureter, and these cases coming to examination later are considered to be of congenital origin whereas in fact they are indirectly the result of inflammatory changes. We recently examined a patient who had a periureteral abscess holding at least 10 cc. of pus in the entire absence of infection of the renal plexus. In this instance it is conceivable that with the healing of the inflammatory lesion, the sphincteric mechanism may be destroyed with eventual dilatation of the ureter.

Dr. HUGH H. YOUNG, Baltimore: The subject of dilated ureters without apparent cause is one of great interest and importance and I believe much more common than generally supposed. I have found a definite number of these cases to be due to valve in the posterior urethra in the male and on this account I consider it very important to obtain cystograms, which will often demonstrate a dilated prostatic sphincter and dilatation of the upper part of the prostatic urethra as far as the valves or diaphragm, which is located usually at the top of the verumontanum.

I remember particularly a child who came into the hospital complaining of urinary incontinence. There was a long foreskin and we were inclined to believe at first it was the usual case of enuresis. The urine, however, was found to be of very low specific gravity and a functional test showed only a trace of 'phthalein in two hours. Attempts were made to pass an ordinary catheter and small sound, but an obstruction was met with in the deep urethra and when finally a ureteral catheter was passed considerable residual urine was withdrawn and cystogram obtained. A marked dilatation of the prostatic urethra above the verumontanum was shown demonstrating the presence of congenital valves in the prostatic urethra. I constructed an especially small endoscope and was able to see these valves and the opening between them which was on top of the verumontanum. It was possible also to pass a child's cystoscope through this

slit after dilatation and to see the falciform upper surfaces of the valves with a deep pouch in the prostatic urethra.

In order to avoid the suprapubic operation which I had usually carried out in these cases, I constructed in the Brady shops a very small "punch" with which the valves were easily entrapped and excised completely, thus curing the obstruction and restoring the child to excellent health.

In another case, a boy of sixteen, the right ureter was so greatly dilated that it was possible to pass a cystoscope through the enlarged orifice up above the pelvic brim and almost to the kidney itself.²

In another case, however, that of a woman, no cause whatever could be found for very greatly dilated ureters. She was a woman about thirty-five years of age (B. U. I. no. 5168) with no history of venereal disease nor urinary trouble, until ten years before when she began to have burning on urination which came on in intermittent attacks lasting one or two days. Five years ago she first began to void at night. The burning and frequency of urination gradually increased in severity and the urine became purulent. She has never passed a calculus but in recent years has had a dull pain in the right side, which is still present, and she still suffers from marked frequency of urination in the day and burning on micturition. There was apparently never any difficulty of urination.

At cystoscopic examination nothing definite was made out except a chronic cystitis. There was no valve or bar at the vesical orifice, ureteral orifices were not enlarged and these were catheterized. We found the ureters markedly dilated with purulent urine and bacilli on both sides. X-ray showed an enormous dilatation of the ureter on each side, as shown in the accompanying radiograph (fig. 1), in which marked dilatation of the calyces, pelves and ureters are seen on both sides. 'Phthalein appearance time was five minutes; elimination in two hours, 10 per cent; blood urea, 1.16 grams per liter.

A suprapubic operation was done with the idea of relieving the back pressure upon the kidneys. Inspection of the bladder

² See complete report, Young, Frontz and Baldwin, *Jour. Urol.*, 1919, iii, no. 5.

showed no trabeculation, pouches, cellules or diverticula; ureteral orifices were pin head in character and when pressure was made with retractors on the posterior wall of the bladder a steady stream of urine came out from each ureteral orifice, showing considerable dilatation of the ureters with fluid but no tight stricture. Ureteral orifices seemed a little higher than normal, posterior portion of the margin apparently a little elevated and the muscle a little thicker than normal, but the orifice was easily dilatable and there was apparently no contracture of the orifice or valve present. A small sound was passed without difficulty into each ureter without meeting any stricture or valve, but at a point about 1 cm. above the orifice a muscular ring was present which seemed definitely thicker than the normal bladder muscle, but even this was easily dilated with successively increasing sounds. The terminal portion of the ureter was then divided along the anterior surface with a probe pointed bistury and the orifice enlarged until the finger could be easily introduced into the greatly dilated ureter. Inspection showed no valve nor post-vesical pouch or point of obstruction above the bladder. The object of these procedures was to completely relieve the ureter and kidney of back pressure with the hope that there may be a restoration of function. Eleven days after operation the blood urea had dropped to 0.66 gram per liter, but unfortunately the patient developed pleurisy and thrombo-phlebitis of the left femoral and iliac veins and died seven weeks after the operation. An autopsy was not obtained.

I have given this case in detail because the subject is one of great interest and cases in the literature are of great rarity.

Dr. J. DELLINGER BARNEY, Boston: About three years ago I had a young man with a fractured spine in whom I found a right pyonephrosis with a large stone. Right nephrectomy was done. Realizing that his left kidney was the keystone of his arch I cystoscoped him from time to time and washed out this kidney. He lived for three years and then died of sepsis from a gluteal abscess. As time went on during those three years, very definite changes could be seen in the base of the bladder so that

finally the orifice of the ureter was displayed and so large that I think I could have put a lead pencil in it. It had dilated tremendously, so that I could look up into it for an inch or two. The change was possibly due to some of the atrophic nerve changes of which Dr. Harpster has spoken. In spite of his paralysis he emptied his bladder very successfully, so that back pressure was not a feature. During this time the remaining kidney was almost free from pus and only an occasional colon bacillus could be found in the urine. I believe renal lavage is a highly essential procedure in cases of this type.

Dr. VICTOR D. LESPINASSE, Chicago: In these cases of huge bilateral dilatation of the ureter there are only two possibilities: Either there is a nerve lesion or there is an obstruction at the bladder neck, or in the posterior urethra. I have had 3 cases of large bilateral ureteral dilatation, two young men under thirty. Both had an obstruction of the bladder neck in association. This fact to me shows that there was something wrong in the embryology of these particular individuals. There were no changes in the posterior urethra, nothing wrong, such as a valve or stricture. The third case was a boy about fourteen who, as far as we could determine, had no lesion whatsoever except the dilated ureters. There were no changes around the vesical orifice or in the posterior urethra. The cause of his condition was uncertain, but these cases should be looked over carefully. There are two types, one neurological. If we strip the ureter in operating to examine it, later on we may find it is dilated because you have interfered with the nerve supply. I feel, however, that most of these cases are mechanical, due to obstructions in the proterior urethra or bladder neck.

Dr. A. HYMAN, New York: We have been interested in following a type of case similar to that described by Dr. Laurie, occurring in young children. Many of them are undoubtedly overlooked. The condition is in all probability a congenital one. We have observed approximately 20 cases, ranging in age from six months, to seven or eight years. The little patients on exam-

ination present all general and local signs of a chronic vesical retention. The etiological factors are varied; some are due to mechanical obstructions in the posterior urethra or at the bladder neck; others have a neuro-muscular origin. In a recent case, operated upon by Dr. Beer, there was found a definite contraction of the neck of the bladder. A wedge-shaped piece was excised, following which the residual urine dropped from 6 ounces down to less than an ounce.

Dr. CHARLES M. HARPSTER, Toledo (closing): I think the interesting discussion emphasizes the importance of the use of these agenices in making the diagnosis. I can add nothing to what has already been said.

Dr. T. F. LAURIE, Syracuse (closing): In this case there was apparently no obstruction at the vesical neck or in the ureters. One looked about the size of my finger, the other was about the size of the head of a match. This may have been a paralyzed bladder, but if so it would have been filled with rugae instead of having a perfectly smooth mucous membrane. There was no injury to the spine or spinal cord and the only thing I can see is the infantile cause and disturbance of innervation.

Dr. H. D. FURNISS, New York (closing): A word in discussion of the paper of Dr. Scholl. I have seen a number of these dilated ureters in cystitic bladders. The dilatation is evidently the result of increased retrovesical tension that so often is present in infected bladders. In the tubercular conditions the dilated ureter belongs to the unaffected kidney, the contracted and retracted ureter to the tuberculous kidney.

Dr. W. F. BRAASCH, Rochester, Minnesota (closing): In a paper on the diagnosis of anomaly in the urinary tract by means of pyelography, published in 1912, I mentioned that the diagnosis of partial duplication of the upper ureter could be made without withdrawing the catheter. It is usually unnecessary to withdraw the ureteral catheter to the lower portion of the

ureter since the pyelographic medium will usually regurgitate into the second division of the ureter and pelvis.

Dr. Young is correct in stating that bilateral duplication will be diagnosed oftener in the future with the aid of pyelography. Pelvic duplication, however, occurs more often unilaterally than bilaterally.

I wish to thank Dr. Chute for reporting the case of the union of the two divisions of the ureter just above the bladder. I reported a similar case and some one raised the question whether, on embryologic grounds, it could be possible. His is evidently the second case.

It is evident that through the wide use of pyelography we will have more reports and illustrations of ureteral and pelvic anomaly such as we have had this afternoon.

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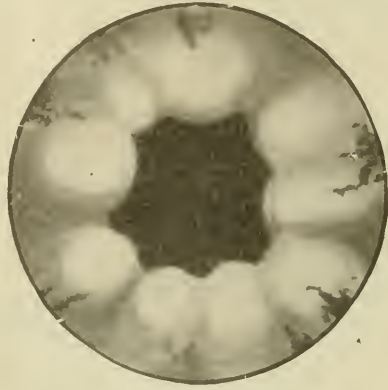
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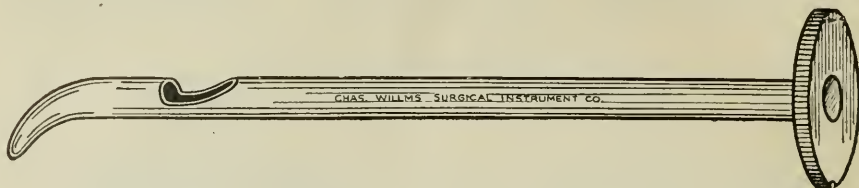
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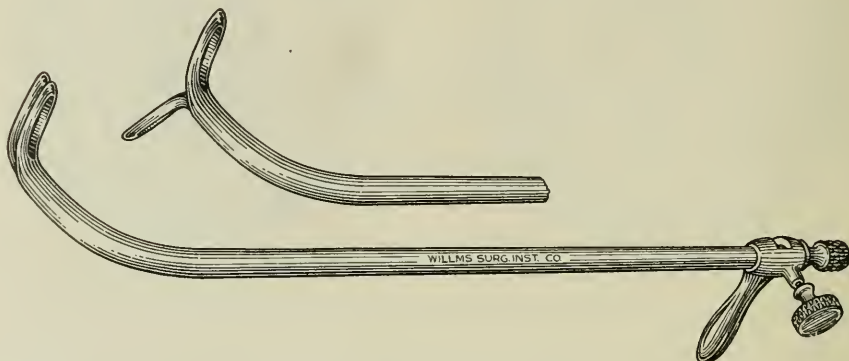
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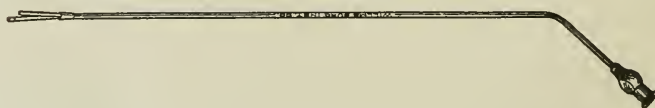
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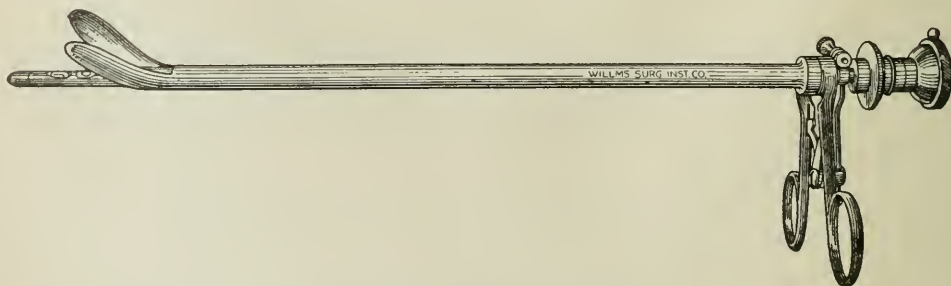
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